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THE TWELVE PRINCIPLES OF EFFICIENCY.

By Harrington Emerson.

VI. THE FOURTH PRINCIPLE: DISCIPLINE.

"Undisciplined"—that is the word. It is the word for all the progress of the Victorian time, a scrambling, ill-mannered, undignified, unintelligent development of material resources. Want of discipline! The reek and scandal of the stockyards is really only a gigantic form of that same quality of American life that in a minor aspect makes the sidewalk filthy. Each man is for himself, each enterprise; there is no order, no provision, no common and universal plan.

Men are makers—American men, I think more than most men. One sees the light of a new epoch, the coming of new conceptions, of foresight, of large collective plans and discipline to achieve them.
H. G. Wells. The Future of America. Chapter 4, Section 4.

ALEXANDER DUMAS in that most famous of his novels, makes Monte Cristo the hero of one episode of marvelous improbability.

In Italy Monte Cristo had accepted an invitation to breakfast in Paris three months later and had agreed to appear on the minute. On the date appointed the other guests were assembled, very skeptical as to the coming of the mysterious Count of whom no word had been heard since the invitation. The guests are impatient—the host begs for five minutes leeway—the clock begins to strike—expectation rapidly sinks towards absoulte zero when suddenly, immaculately dressed, Monte Cristo appears saying "Punctuality is the politeness of kings, but it cannot always be that of travelers and fifteen hundred miles are not easily covered. Excuse the two or three seconds I am late."

It was beyond even Dumas' imagination to state that Monte Cristo started on his long trip also on time and made each stage of the journey day by day, hour by hour, on time. Under the dependent sequence of personal arbitrariness and unstandardized road and horse conditions it was indeed marvelous that he should arrive within a week of the time set, much less within a day, an hour, or a minute.

Now hundreds sweep over the nearly thousand-mile stretch between Chicago and New York on Monte Cristo's fraction of a minute precision. They start on the minute, they pass each station on the minute, they arrive on the minute, the passengers grumble mightily and the railroads pay rebates if there are delays.

The institution built up on time schedules has become mightier than the man and the man is immensely benefited by the discipline of the institution.

Thirty years ago along the great inland rivers of the United States, the Ohio, the Mississippi, the Missouri, the greatest difference was apparent between the river towns and the railroad towns. In the river towns steamboat passengers were quite content to wait several days, idling on the levee, whittling or swapping yarns or doing the *dolce far niente* on the hotel piazzas. When far up or down the river the deep bellow of the boat's whistle was heard, day or night, the sleepy town awakened into prodigious and spasmodic activity until the boat had come and gone; then it went to sleep again. Clocks were not needed and all business was conducted on the same easy lines. Notes were paid, not when they were due, but when the crops were marketed. An Eskimo who figures years as so many snows, months as so many moons, and days as so many sleeps, would have found the business methods of the steamboat town wholly normal—steamboat coming down the river, great excitement; whale seen in the offing, great excitement—what was the difference? In the railroad towns there was a very different spirit. People had clocks in their houses and watches in their pockets; they went to the railroad station on railroad schedule time; the coming and going of the daily trains became definite, regulating and educational events even to those who never traveled; they got into the habit of keeping other appointments; they were beginning to learn that the institution was greater than the individual.

The near discipline of the rich man who makes his servants await his convenience in spite of a definite program arranged by himself, the near discipline of some railroad magnates who more or less disarrange the train despatching on a whole system by their lack of observ-

ance of their own special train schedule, the near-discipline that would bend the sublime order of the universe to individual dilatoriness as in the story of Joshua's command to the sun to stand still, is not what is meant by "Discipline" as an efficiency principle.

There is the discipline of life which leads us, almost compels us, to follow the teaching that comes to us from intimate contact with the existing order. "The wicked shall not live half their days." It is easier to learn to fly than to make a landing. In a narrower sense we speak of the discipline of St. Francis, of St. Dominic, of Ignatius Loyola, meaning not punishment but a definite, regulated life, conduct, and observances. In the narrowest sense we use the word to denote the act of punishment inflicted on a bad boy with the object of encouraging observance of prescribed conduct or rules.

The word discipline thus has three—if not more—meanings.

Adam began to experience the discipline of life when Eve became his daily companion; discipline and the greater life began in earnest for both of them when they found themselves outside the gates, with Cain, Abel and Seth frisking around, for there is no such catagorical imperative as the sharp outcry of a very young baby. Adam and Eve, owing to lack of experience and overvaluation, spoiled Cain; so being undisciplined, his exaggerated personality could not brook the preference shown Abel and he murdered him.

Discipline as an efficiency principle includes all meanings, from lessons of life to man-inflicted punishment. The greatest regulator of conduct is the spirit of the organization.

I did not like being the only man in a dress suit at an informal business men's dinner in Boston, nor did I like being the only man in flannel shirt and mucklucks at a Nome ball. The spirit of a place is intangible, but counts for more for either evil or good than all rules and punishments combined. So powerful is this spirit that it has been cynically said most men would have fewer conscience pricks over an undetected crime than over a ridiculed solecism.

Is it not incredibly short sighted to throw to the winds such mighty helps to discipline as the spirit of the plant, the general scheme of conduct, and to place reliance in the undisciplined acts of discipline of individuals clothed with a little brief authority?

Nature is a relentless disciplinarian.

Because the success of the whole plant depends not on its wealth, or its men, or its product, but on its spirit and rule, penalties for persistent infraction should be relentlessly severe. A whole race is exterminated in Africa because through ignorance it braves the bites

of the tse-tse fly. If we fall asleep in charcoal fumes we do not awake, if we touch hot iron we are burned, if we put our heads under water for five minutes we drown, if we touch through mistake a live high-voltage wire, the penalty may be instant death. There are no rules and regulations about these punishments, they need no rules and regulations.

The old story runs that Eve and Adam were banished from Paradise for eating a forbidden apple and that all their descendants not only cannot get back except by very special favor, but will have to spend all eternity in hell. Cain's punishment was also exclusion; he became a fugitive and a vagabond, he was not to be rewarded for his work and he bitterly complained that his punishment was greater than he could bear. One, Cook, wrote a cheerful book about scaling Mount Bulshaio and later sent some thrilling messages about the North Pole. Not because Peary accused him, which most people resented, but because his own stories and acts proved him a liar, he had to flee, like Cain, into obscurity and oblivion although no man pursued.

Enforced resignation is one of the severest penalties in the army and navy; on a great railroad in the middle west employees were rarely discharged; they worked themselves up or down by an automatic system of merit and demerit marks. In another great American business, a large specialty store, the making and enforcement of rules is turned over to a committee of the employees. It is a universal experience that no judge is as severe and unrelenting as the more righteous contemporary with the same temptations and opportunities. It is not the child, the man, or the older woman who condemns Magdalen. It is not the child who pities the playmate killed by carelessness, it is not the successful old man who pities the grey-bearded derelict who has made a general shipwreck of life.

If the spirit of the plant does not drive an undesirable associate away, if standard operation and standard practice, both of which affect conduct, if reliable, immediate and adequate records, if absence of efficiency reward do not automatically, effectually and peaceably eliminate the undesirable, it is time for the strong hand to descend. There are certain all-night restaurants in the tenderloin district of New York frequented by roysterers of both sexes after the more reputable places are closed. A good-natured tolerance prevails for even unusual hilarity and noise, but just let any misguided guests try to start something, they suddenly find themselves seized and deposited outside on the car tracks with locked doors between themselves and joy. The disciplinary hand is resistless, immediate and strong.

Under the best management there are scarcely any rules and there are fewer punishments. There are standard-practice instructions so that every one who may know what his part in the game is, there is definite responsibility, there are reliable, immediate and adequate records of everything of importance, there are standardized conditions and standardized operations and there are efficiency rewards.

There can be organization without discipline, as in all plant life; there can be discipline without organization, as in most animal life. Because man has supernal ideals; because the progress of centuries can be lost in a year, in a minute, even (as during an earthquake) if organization is weakened—the devil indeed catching the hindmost; because our unstable human organizations, even the integrity of the family, depend on discipline, it becomes a fundamental efficiency principle which continuously, vigorously, never falteringly enforces a series of standards of high individual or combined conduct.

"He that ruleth his spirit is better than he who taketh a city." Discipline is not arbitrary rules with punishment for short-comings real or imaginary.

The tremendous simplicity of the scheme of the universe is the real marvel of it all. Universal attraction and universal repulsion—all elements have approximately the same atomic heat—but three principles underlie all life—self-preservation, race-perpetuation and the proprietary instinct. From a few elementary laws, other universal laws spring; and any near-law that cannot trace its parentage straight back to one of the supernal laws, if indeed there is ultimately more than one supernal, is probably not even a legitimate near-law.

Fine manifestations of disciplined performance are the four eighteen-hour trains each day between New York and Chicago. So unobtrusive is the perfect discipline that the passenger sees no rules or orders given, he does not see the far ahead light or semaphore signals that govern progress, he sees still less the telegraphic messages flashed by the dispatchers to the signal towers, he knows little of the duplicate orders issued to conductor and engineer. The discipline is that of the velvet paw armed with the sharpest claws, infraction possibly resulting in destruction of the whole train, a trans-human punishment; infraction, even if there is no immediate disaster, resulting in reprimand or dismissal.

Many years ago I became interested in a socialistic experiment on the shores of the Pacific. In that favored region of mild climate, tall timber, waters teeming with fish, woods alive with game, the earth covered with fertile soil, a man and woman would be justified

in starting married life with a fish net, an axe and a spade, a cook pot and a jack knife. They might catch enough fish in a single day to last a whole year, and if it was not the season for fish, they could dig clams with the spade, pick wild berries in abundance, and easily split cedar logs, for canoe or hut. The skins of wild rabbits furnish blankets and clothes.

It was in this part of the country that a band of earnest men and women, some militant, some supine, some altruistic, some selfish, but all dreamers, resolved to start a socialistic colony, "to ease the strong of their burden, to help the weak in their needs." Members were either to contribute or to work. Contributing members were to pay $2.50 a month to be spent in the purchase of land, implements, machinery, and all else that the colony could not make for itself. Working members were to clear the ground, erect buildings, build boats, sawmills. Capital exacting no interest, labor never striking, were to combine in making the wilderness a paradise.

The contributing members, in case of disaster overtaking them in the outer world of competition, were to have the right to move at once to the colony where they and their children would find a ready-made home, an asylum from want and poverty, becoming working members as strength and ability permitted. Ranks of workers were to be recruited, partly from contributing members, partly by admission. The plan seemed feasible, especially as a large tract of valuable meadow and forest land was given by one of the enthusiastic founders, a theosophist who lived altruism.

I spent some time at this colony as a visitor. I met noble men and women, but I also met drones who lolled in bed while others worked, drones who expected to be waited on, and as I watched I came to admire the spirit of the beehive which ruthlessly cuts off the wings of useless drones and pushes them outside the hive to perish.

I also noted that capital and labor in combination are not enough, that the essential to direct both is after all the organizer, the disciplinarian; and I perceived that it was the discipline of St. Francis, the discipline of St. Dominic, the discipline of Ignatius Loyola, that made these great monastic and religious orders enduring and successful century after century, even as it was the discipline of the Old Man of the Mountain and his successors in spite of their atrocious practices and beliefs that maintained for two hundred years the power of the sect of the Hashishim or Assassins.

So great is inefficiency of all kinds everywhere that the appli-

cation of even this one principle of discipline has produced great results through military or church organizations. Just as soon as a community bends to discipline, whether its members are followers of Romulus, of Leonidas, empires are either founded or shattered, and just a little discipline as to dress and work have made such American communities as the Shakers, Economites, Mennonites, wealthy. In the army, as in the church, the first vow is obedience; and in Schiller's ballad the slaying of the dragon did not save St. George from condemnation and punishment for his disobedience. The large office buildings in New York are peculiarly dependent on discipline. They are miniature cities in which all municipal activities, lighting, heating, cleaning, transportation, are constantly going on. As long as the tenants are present from 8 a. m. to 5 p. m. high order is maintained, but shortly after 5 o'clock discipline relaxes, attendants raise their voices, begin to smoke cigarettes, to romp, and the conviction grows that if these modern palaces were turned over as a possession to their own trained attendants, in an incredibly few weeks they would be marred and scarred, dirty and disorderly, physically and morally.

Family life can exist in the Gypsy caravan or in the Arab tent or Indian tepee, in the wolves' den or in the bird's nest, but we owe the continuance of civilization to the citizen efficiency and standard-practice engineers, men and women, heads of great institutions, governments, corporations and enterprises, who design and erect the firm skeleton of discipline that maintains in place the units of individualism, lest the whole aggregation tumble to ruin at the first shock in earth or air.

In marked contrast with the vagueness and looseness of obligation and control in the social colony that failed, is the high organization and discipline of modern baseball teams in which individual effort and reward has been happily combined with team work and collective reward. In baseball each man disciplines himself; to this is added the discipline of the team, and on top comes the discipline of the league. Without high individual standards, without team codes enthusiastically lived up to, without severe penalties to enforce obedience to the umpire and peace between the teams, the modern game would be impossible. It is the spirit of discipline, not its letter, that counts, and the spirit is reciprocal from bottom to top, from top to bottom and sideways to all associates; it is reciprocal beween the individual and the flag under which he is industriously enlisted.

I have been asked why "co-operation" was not to be considered as one of the twelve basic principles of efficiency. Common ideals

striven for by a disciplined organization, supernal common-sense which forgets the little for the sake of the larger achievements, necessarily result in co-operation, even as the bees, having accumulated a full store of honey, seem to obey a queen, who "as it happened with many a chief among men, appearing to give orders, is himself obliged to obey commands, far more mysterious than those he issues to his subordinates." The fundamentals of discipline are in fact better learned from the government of a beehive than from college courses, from armies, or from any industrial organization. No bee appears to obey any other bee, no bee seems consciously to co-operate with any other bee, yet so perfect is the "spirit of the hive" that every bee engrossed in her special task, fatalistically acts on the instinct that all other working bees are also as busy for the common good, and when the drones fail to be useful the working bees become consciously indignant and make away with them. Co-operation is a matter of course, not a virtue; its absence is the crime.

Supernal discipline is inspired by a greater emotion than fear.

Frank T. Bullen, in his story praised by Kipling, *The Cruise of the Cachalot*, describes the high type of reciprocal faith that in great emergency resulted in a perfect discipline, and the story in abbreviated quotation illustrates what is meant by discipline inspired by faith.

At Port William, New Zealand, two whale ships lay, the Tamerlane and the Chance. The American Tamerlane was neat, smart, and seaworthy, but the colonial Chance looked like some poor relic of a by-gone day. Old she was with an indefinite antiquity, carelessly rigged and vilely unkempt, but the old Chance made a better income for her fortunate owners than any of the showy, swift, coasting steamers. Captain Gilroy, familiarly known as "Paddy," the master of the Chance, was unsurpassed as a whale fisher or seaman by any Yankee that ever sailed from Martha's Vineyard. He was a queer little figure of a man—short, tubby, with scanty red hair and a brogue thick as pea soup. Overflowing with kindliness and good temper, his ship was a veritable ark of refuge for any unfortunate who needed help, which accounted for the numerous deserters from Yankee whalers who were to be found among his crew. Whaling skippers hated him with ferocious intensity, and but for his Maori and half-breed body-guard he would have been killed. On that storm-beaten coast he knew every rock and tree in fog or clear, by day or night, he knew them as the seal knows them, and feared them as little. His men adored him, they believed him capable of anything and would as soon have doubted daylight as the wisdom of his decisions. One common interest, their devotion to their commander, united the very mixed crowd, sixteen European and American sailors, twenty-four Maoris and half-breeds. . . . . The Chance was there and three other whalers, competitors. Without any warning the wind flew around into the northward, putting the four ships at once into a most perilous position, and there to leeward loomed grim and gloomy one of the most terrific rock-bound coasts

in the world. The Chance was a good mile and a half nearer the shore. The sea, gathering momentum over an area extending right around the globe, hurls itself upon these rugged shores. As the craft drifted helplessly down upon that frowning barrier, excitement grew intense. It would not be possible for them to escape if they persisted in holding on, but it was easy to see why they did so. Paddy, far to the leeward, was in much more imminent danger and it would be derogatory in the highest degree to the reputation of the other captains were they to slip and run before he did. He however, showed no sign of doing so, although they all neared that point from whence no seamanship could deliver them and where death, inevitable, cruel, awaited them. A gigantic barrier of black naked rock rose seven or eight hundred feet sheer from the sea. Nothing broke the immeasurable landward rush of the majestic waves towards this world-fragment. Against this perpendicular barrier they hurled themselves with a shock that vibrated far inland and a roar that rose over the continuous thunder of the tempest-riven sea. High as was the summit of the cliff, the spray rose higher so that the whole front of the great rock was veiled in filmy wreaths of foam.

Towards this dreadful spot the four vessels were being resistently driven. Suddenly, panic-stricken, the ship nearest the Chance gave a great sweep round onto the other tack. They had cut adrift from their whale, terrified beyond endurance into the belief that Paddy was going to sacrifice himself and his crew in the attempt to lure them with him to inevitable destruction. The other two did not hesitate longer.

The Chance drew in closely to the seething cauldron of breakers.—Who among sailor men having seen a vessel disappear from their sight under such terrible conditions ever expected to see her again?

It appeared that none of the white men on board, except Paddy, had ever before been placed in so seemingly hopeless and desperate a position, and yet when they saw how calm and free from anxiety their commander was, how cool and business-like the attitude of all their dusky shipmates, their confidence kept its usual high level. The test was of the severest, for to their eyes no possible avenue of escape was open. Along that glaring line of raging, foaming water not the faintest indication of an opening. The great black wall of rock loomed up grim and pitiless. All stood motionless with eyes fixed in horrible fascination upon the indescribable vortex to which they were being irresistibly driven. At last, just as the fringes of the back-beaten billows hissed up to greet them, the ship plunged through the maelström of breakers—they were on the other side of that barrier, the anchor was dropped, the vessel rested like a bird in her nest on a deep still tarn, shut in on every side by huge rock barriers. Of the furious storm, but a moment before howling and raging, nothing remained but a thunderous hum, and high overhead the jagged, twisted, tortured cloud, whirling past their tiny oblong of sky.

Such a feat of seamanship was almost beyond belief. The little, dumpy, red-faced figure, rigged like a scarecrow, bore no outward visible sign of a hero, but in our eyes he was transfigured, as one who in all those qualities that go to the making of a man had proved himself of the seed royal, a king of men, all the more kingly because unconscious that his deeds were so exalted.

If this disreputable little Irishman in the midst of filth and inadequacy could maintain, by qualities of soul alone, a discipline so admirable among a crew of flotsam and jetsam under stress so

terrible, what ought not to be accomplished by leaders with all the advantages of education, experience, organization, with picked crews of workers? Unless I know that the employer is without fault, unless I know that he is struggling with an inherited, vicious condition, I have no patience with so-called labor troubles, almost always due to neglect of elementary precautions for the common benefit of master and man. There is at least one large business aggregation in the United States in which a strike is unthinkable because it is a coveted privilege to be admitted to it as a worker, a catastrophe to be cast out, and so high is the *morale* that the workers themselves make and maintain standards of conduct far stricter than any usual employer would dare to enforce although he may print and post rule after rule.

The time to inspect boiler sheets is before they are made up into steam boilers; the time to inspect anchor chains is in the making, not when the great steamer is straining with broken machinery to the windward of the Scilly Islands in a midwinter storm. In all industrial life everything is tested, materials, design, except the all-important men. In the little shop, rigidity of human inspection is high, the master looks over each man, has probably watched him for months or years before engaging him; but in the large shop, where the personal inspection of master has become impossible, even the most elementary safeguards are thrown to the winds and men are absorbed with less discrimination than the furnace under the boiler absorbs air.

No man enters West Point without passing severe elementary examinations. It is a tremendous privilege to be admitted, a disaster to be excluded. There ought to be a high membership ideal for every plant, no newcomer admitted who was not fit in every way, no man cut off except for cause. Discipline begins before the applicant is taken on. Nine-tenths of all the harder discipline ought to be applied to exclude undesirables, men who by reason of bad character, bad and offensive habits, destructive tendencies, laziness or other faults, are unfit to become working members of a high-class organization. It is before he is admitted that the applicant should hear of the ideals of the business, of its organization, of its methods.

In railroading, why should each conductor and engineer be compelled to secure a watch of the best grade, why should this watch be periodically inspected, yet the future conductors and engineers be recruited in the most haphazard fashion? There is scarcely any greater or crueler injustice to a boy or to a young man than to allow him to enter on a career for which any competent examining

committee would tell him he was unfit, there being other careers for which he is better adapted.

In coal mining, seams of coal with bands of slate, clay, or dirt are not mined, or the coal is carefully picked over, or washed; in lumbering all material is graded, millions of feet of inferior grade being burned; in wheat raising the farmer strives to attain grade; standards are devised and rigidly adhered to in the live-stock markets; but a company building cars or running a factory or mining coal will engage and employ almost anyone that applies for work, who is not under age, over age, or absolutely crippled.

The master organizer, whether saint or assassin, does not admit those who would make trouble and thus avoids nine-tenths of possible insurrection, the master organizer creates a collective spirit that prevents another nine-tenths of disciplinary troubles, a dependent sequence that brings his remnant of insubordination down to one per cent of the usual and possible and with this one per cent of remnant he easily deals.

As I write, the morning papers contain three items. "Manchester, England; The Federation of Master Cotton Spinners has locked out 130,000 men. Berlin, Germany; Negotiations with the object of preventing a lockout of the metal workers have failed. Nearly 100,000 men are affected in Berlin alone, it is estimated that at least 500,000 throughout Germany will be turned out. Paris, France; 80,000 strikers tie up railroads. Entire country may soon be involved."

Whatever the merits of the cases, it is safe to say that most, if not all, the principles of efficiency were flagrantly absent in these three great disputes. In the case of the cotton spinners the story runs that a worker was discharged by a foreman because he objected that certain assigned work was not in his line. Ought it to be possible for two men in the bottom ranks of a great business to bring on a strife involving 130,000? Were his duties made clear to the worker before he entered the company's employ? Ought the foreman to have had the power to discharge him for an objection, on its face, entirely reasonable and sustained by his fellow workers? In this dispute we have the old-type, arbitrary, anarchical organization of both masters and men. We find first of all defective discipline, rejection of competent conciliatory counsel, painful absence of common sense, and no high ideals.

Under efficiency principles there would have been staff advisers to invent and build up safeguards against catastrophies of this nature, just as levees are built along the banks of rivers inclined to flood.

Trouble-making men, whether workers or foremen, could neither have gone on the payroll nor have stayed on it. There would have been staff conciliators whose business it would be to take in hand incipient emotional flames and smother them before they grew into great conflagrations.

The principles of efficiency are not vague platitudes; they are intensely practical remedies, tested, tried out, and successful in preventing wastes, preventing the losses caused the State and community by the cessation of labor of hundreds of thousands of men, preventing the greater misery and suffering due to the enforced idleness of heads of families. While master and man quarrel and bicker, the State suffers and women and children pay the penalty. Socialism gains recruits not from the arguments of its advocates, since no human being is naturally a socialist, but from the unendurable shortsightedness and shorter temper of individualistic men.

It is not enough for the owners to have ideals; they must be transmitted to the employee, and nothing is easier, as any one who has studied the psychology of crowds knows; but it is idle to expect the average worker to rise above the spirit of the place he works in. If it is untidy, disorderly, filthy, if the accommodations for his necessities are lacking or vile—imposing steel and concrete construction, saw-tooth lighting, compound condensing engines, and all the overequipment to which in the past we have pinned our faith, will not inspire the worker.

On one occasion, beginning an investigation of a great machine shop employing one thousand men, I went the first morning at half past six to the power house. It was a dark day early in February, temperature 8 degrees below zero and the shops were none too comfortable. When the whistle blew at seven o'clock I watched the ammeter line. The power consumption rose instantly to what proved to be the average maximum and it stayed up. I returned at 11:30 and watched the ammeter line stay up until 11:57 at which time the record, reliable, immediate, and adequate, began to round off, suddenly dropping as the noon whistle blew. It came up again at 1 o'clock and stayed up until 6 o'clock. The two parallelograms were very different from the flattened records, shaped like half ellipses, so usual in similar shops. It was evident that the superintendent was a man of discipline, and the opinion I formed in that forenoon of his ability was confirmed by three years' intimate association. It was his practice to enter the shop at 6:30 a. m. to stay until after 6 p. m., and I heard him severely reprimand a

foreman for allowing the superintendent's father, a worker in the shop, to take off his overalls five minutes before closing time. Men worked enthusiastically, loyally, and reliably for this master of men.

The way to guard against trouble is to make the position desired by a superior man, to allow it to be filled only by a superior man, to maintain the position at a high level. If the owners and managers of a plant of any kind are orderly, enthusiastic, loyal to the work, punctual, courteous, decent, competent; if they feel their obligations towards those they direct; if they are honest, economical, diligent and sound in health, they can well demand similar qualities in all the employees. I have placed order first, believing in the spirit of the proverb that order is nature's first law and also the remark which Goethe puts into the mouth of Mephistopheles: "Make use of time, it is so fleeting, but order saves time." No man ought to be allowed to enlist who cannot start in with order, enthusiasm, loyalty, reliability, who is not courteous and decent; no man ought to expect to stay who is not competent, a good brainworker, honest, economical and diligent. If in addition he has good health, so much the better.

The self-executing discipline that is worthy to be an efficiency principle is the allegiance to and observance of all the other eleven principles, so that the twelve principles do not become twelve rules unrelated to each other; they do not become separate and easily dislodged rails of a fence, which is more an indication of boundary than a barrier; they do not even become the iron palings of a French fence, whose spacings as a boy I had carefully tested by my head, knowing that where this member could pass my body could slip through—much beloved interstices, an ever ready path to safety when pursued by outraged minions of the law or exasperated householders or other representatives of the established order against which I was in perennial rebellion. As promoters of observance of arbitrary rules to which as a free American boy I had not given my assent, these elaborate fences were joyful failures.

It is otherwise with the rabbit-proof, dog-proof, hog-proof, bull-proof, wire-netting fence whose meshes cannot be squeezed apart, whose barbs punish familiarity, which is strong enough to kill outright an animal running diagonally against it.

The twelve principles of efficiency are the strands of a net, each interwoven with the other so that in reality the first study of any organization is to find out to what extent common-sense, competent counsel, discipline, and the other eight principles have been applied

to the first principle, "Ideals"; to find to what extent ideals, competent counsel, and discipline, have been applied to common-sense; to find to what extent ideals, common-sense, competent counsel, have been applied to discipline. Any system or act of discipline that cannot pass the test of each of the other eleven principles is near-discipline, not supernal discipline—is a remnant of arbitrary individualism, the first misstep in an anarchy that will extend all the way down the line.

No efficiency principle stands alone, each supports and strengthens all the rest, each is supported and strengthened by the other eleven. They are not as mutually interdependent as the stones of an arch, each a key stone which if removed brings about the collapse of all the others; they are more like the stones of a dome, any one of which can be taken out, leaving a weakened, but not a destroyed structure.

DIVISION OF LABOR IN BITUMINOUS COAL MINING.

By W. E. Fohl.

Mr. Fohl's article speaks for itself by its able and clearly presented thought. It is placed beside Harrington Emerson's statement of efficiency principles so that emphasis may fall on the sympathy in operation of two minds working independently on similar problems—the one general, the other specific. Mr. Fohl connects the admitted inefficiency of bituminous coal mining with certain definite factors:—an evasion of the fair deal by the operating companies; lack of competent counsel to the miners; lack of standard-practice instructions; incomplete discipline. These involve four of the Twelve Principles of Efficiency. When different investigators working separately arrive at substantially identical results, it greatly strengthens the argument that these results embody fundamental facts or natural laws and principles.—THE EDITORS.

WITHIN the last two decades there has been an enormous expansion of the bituminous coal-mining industry, from a production of 111,302,322 tons and the employment of 192,204 men in 1890 to a production of more than 300,000,000 tons and the employment of more than 500,000 men in 1909. This growth has been accomplished partly by the discovery and development of new coal areas and the multiplication of operations in the older mining regions, but principally by increasing the productive capacity of individual operations, few plants being now built of less capacity than 300,000 tons annually.

During this period engineering talent of a high order has fastened its attention on the perfecting of the physical organization, and carefully planned surface plants, durably built of masonry and steel, and every conceivable device for the economical handling and preparation of the product have resulted. It is a matter considered no longer noteworthy that the trend of the coal seam is determined in advance of operation and that workings are developed along lines previously laid down with but little more variation than the architect finds necessary in his detail drawings of a modern high building. Transportation is effected over roadbeds rivaling trunk-line railways for solidity and permanency, by steel cable, and the more mobile electric or compressed-air motor. Machinery has been applied to the cutting of the seam preparatory to its dislodgment, usually by blasting, and there is continually seen, just ahead, the machine that will cut and load the coal without the intervention of the miner's pick and shovel.

But for each 600 odd tons of coal produced annually there is still required one man, and the aggregate of these requirements for 1909 was more than half a million men. While the physical organization has been gradually brought to a high state of efficiency this great body of labor, as a whole, has deteriorated.

This deterioration has been due to racial changes in the personnel of the workmen, but the casual inference that it is solely due to the inferior mentality of the supplanting Slavonic and Latin races is by no means borne out by intelligent observation. The early miner of British extraction, English, Scotch, Welsh, came into the mines of the United States as a journeyman who had served his apprenticeship in mining communities whose members took their place at the working face in early youth, and in addition, was equipped with a language common to himself and his employers. The later immigrant, however, was an alien in language and was without industrial experience, being the product of agricultural communities. That he is amenable to discipline is a matter of general agreement, and that he is susceptible of training is demonstrated by the number of first-class operations manned by these aliens in all departments except those requiring special mechanical skill or a ready command of the language.

A brief review of the processes of coal production is necessary to determine whether they have been adapted to the securing of the greatest efficiency from untaught labor. The description applies to room and pillar mining which is practiced with very few exceptions throughout the United States.

Formerly the operating company assumed responsibility for the labor only to the entrance of the working place; beyond there the miner was in effect a contractor, who, at a fixed price per ton or wagon of coal, undertook to perform all necessary labor connected with the mining of the coal. He furnished his own tools; laid the track connecting his working face with the company's haulageway, material for this being furnished by the company; and placed the supports for the roof, also with furnished material. The actual mining of the coal he performed by making an undercut at or near the bottom of the seam, afterward dislodging the overhanging coal by blasting or wedging. Some important exceptions to this general method of procedure were the use of a side cut, known as shearing, either with or instead of the undercut; the blasting of the coal from the solid, omitting both the undercut and the shearing; and, in some

localities having coal softer than the ordinary, digging the coal from the solid face with a miner's pick. The miner's labor finished with the loading of the dislodged coal into the wagon.

The loading of the coal into the wagon is the only part of the process not requiring skill in a greater or less degree. In all the labor the miner was left to his own devices, receiving no supervision nor instruction other than could be given during a hurried visit of the mine foreman or his assistant—a visit seldom occurring more than once daily, and seldom of more than a few minutes duration. The working place belonged to the miner, and so long as he was in the employ of the company, no matter how irregularly he worked, it was reserved for him.

The first encroachment on the miner's ownership of his working place was occasioned by the introduction of machinery for cutting the coal more than a decade ago. This machinery, being entirely outside the average miner's experience, from the first called for specially trained operatives and there has never been a suggestion that a knowledge of its operation should be a part of the equipment of the ordinary miner.

The next step in this direction has been the general demand to have the use of necessary explosives put in the hands of men specially trained in their use. As many of the disasters of recent years have been attributed to unskilful use of explosives, this is being widely done with little opposition. In machine mines with shot firers in company employ there is left, then, for the miner the timbering for roof support, the track laying, the drilling of holes for blasting, and the loading of the coal.

The next step in progression—the assumption of the skilled parts of this labor by the operating company, leaving to the miner only the loading of the coal—has scarcely been seriously broached. This has been due partly to a fear of incurring an extra legal responsibility, if timbering were taken out of the miner's hands, and partly to the very natural idea that the miner is more vitally interested than any one else in the preservation of his own safety. This, however, overlooks the inclination to take dangerous chances common to the workers in all hazardous occupations. It is a belief, too, of common acceptance about mines that experienced miners are more likely than raw recruits to be killed by negligence, and a reading of mine-inspectors' reports shows a majority of accidents caused by falls of roof and coal to have occurred after warnings given by those in authority, or by disobedience of rules for the regular placing of supports.

It is easily understood that this labor can be more efficiently performed by men trained for it and constantly engaged in it. Holes for explosives can be placed where they will be most effective, tracks can be laid so that delays from derailed wagons will be at the minimum, and timber can be set where it will give needed support. But most important of all, these things can be done a shade in advance of their actual need, a thing now impossible of practical performance, because the miner's pay is gauged solely by the quantity of coal loaded in his wagon, and these so essential parts of his labor are extras upon which no unit price is, nor can readily be, placed. It seems almost superfluous to add that observation shows the miner constantly bending his energies to the filling of his wagon and constantly being driven to the performance of these extras.

There seems to be little question but that a more rational division of these various labors would make for greater efficiency, especially in mines using machinery for undercutting. Such a division would make use of the present machine runners with no change, these to be followed by men to perform both drilling and shooting. Following these last would be the timbermen who could also have charge of road laying. All of these to be in company employ and working for a fixed daily wage, except the machine runners who could be paid for tonnage cut, as they are now.

An objection to this suggested plan will be found in the fear of employers that their assumption of the miner's timbering duties will make them directly liable for all personal injuries from falls of roof and coal. It will be objected, too, that this plan will cause a disturbance of existing wage scales which have been arrived at only after bitter contention with the miners through their organizations or otherwise.

The welfare of society demands that the first objection should be erased. When the employer has exercised all possible diligence in the furnishing of men and material, such accidents as are unavoidable are properly a charge upon society as a whole, and a world-wide movement is now in progress to fix by legislation the manner in which society shall pay its debt to the laborers injured in dangerous industries, as well as the manner in which it shall care for surviving dependents.

As for the second objection, the disturbance occasioned by the change in wage scales would be only temporary and future modifications would be materially simplified. As it now stands in this in-

dustry, the fixing of wage scales is an attempt to secure an impossible uniformity. The hardness of the seam, its thickness, the character of the roof, are all factors influencing the amount of coal possible of production by the miner. But suppose the working place prepared and the coal dislodged; the miner, or, as he would then be called, the loader, would nearly everywhere perform the same amount of paid labor. The men employed by the day to perform the labor now included with the miner's labor as extras would have their wages fixed with little regard also to mining conditions. They must have a living wage wherever situated. To have them earn this is a matter of supervision, and not necessarily a great deal more supervision than is already being exercised.

The advantages to be derived are far reaching, notwithstanding the apparent simplicity of the change. The loading which consumes roughly three-fourths of the miner's working time would, in consequence, give employment to a large body of men needing no knowledge of the language and no ability other than that involved in the manipulation of a shovel. Work suitable in character would thus immediately be provided for our Latin and Slavonic recruits; their training as citizens and, for those of native ability, as skilled workmen, could then be conducted in a leisurely and systematic manner and not at haphazard as at present.

The death rate in American mines which has been the cause of so much unfavorable comparison with that of European mines would be greatly reduced; for more than half of the fatal accidents are caused by falls of roof and coal. The skilled and unskilled workmen are alike sufferers in this particular, and the proverbial stitch in time is far more likely to be applied by men whose sole occupation is the securing of safety and whose daily earnings are not enhanced by procrastination or slipshod work. Discipline which has for its object the safety of the person disciplined is in America practically impossible of enforcement. Yet, vigilance must be enforced and there seems no surer method of enforcement than to bring it into prominence by making it a paid labor.

A surplus of development is nearly always present in bituminous mines. Idle working places exist for various reasons. Temporarily, because the miner is prone to holidays; and for longer periods, because he is of a vagrant disposition and his unfinished working place is viewed with suspicion by a new arrival. Any untoward natural condition immediately makes a working place highly undesirable, and

even a fair premium will seldom secure its continuance. Now, every developed working place represents an outlay of capital and its idleness is more than mere idleness of capital; it is a bill of expense, not only for its own maintenance but in its retarding effect on the general development. Full recovery of a seam requires that a section once opened shall proceed to exhaustion without pause. This can be accomplished only by a greater mobility of working forces, allowing them to be concentrated at will where needed.

It has come to be a truism that in any industry a study of its human components is of paramount importance. The industry in question deserves a closer study on its human side than any heretofore accorded it. The conditions here reviewed are in themselves trivial, and in an industry employing labor in small numbers would be of little moment. But when it is considered that these conditions are bound fast to one of the major industries of the nation by long years of tradition, and when it is considered that the energies of the larger part of half a million workmen are being inefficiently and dangerously directed, they demand examination in all seriousness.

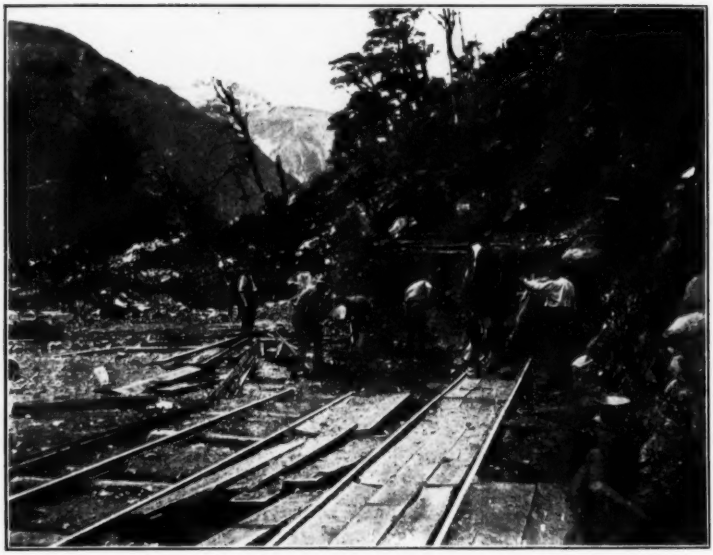
INTERESTING RAILWAY ACHIEVEMENTS IN NEW ZEALAND.

By W. Wilson, B. E.

A large part of the activity of the engineering trade in the past half-century has been based on the development of new territories—especially railway development and its contributory industries. The next very few decades seem certain to witness some change in the distribution of this activity, following the satisfaction of the larger needs of the greatest of the newer continents and the turning of American manufacturers to foreign markets. Hence there is added interest in this short survey of work in a country where the realization of opportunity is still in its active youth.—THE EDITORS.

THE small Dominion of New Zealand has what may justly be considered an extensive railway system. Though the average life of the provinces, which go to make up the colony, is only about 70 years, yet just under 3,000 miles have already been laid down, and the existing lines are being extended at more than a dozen points. This work is being done, and has been done in the past, in the face of great natural difficulties, and as the easiest routes (as might be expected) were proceeded with first, these difficulties are increasing still further. I propose to give a brief description of the methods by which the obstacles met with have hitherto been overcome.

The first railway in the country was the port line constructed by the Canterbury government to connect Christchurch with the sea. It was undertaken soon after the landing of the colonists in 1850, and trains were actually running to the temporary harbour on the Avon, a distance of about six miles, only a dozen years after the arrival of the historic first four ships. At the same time a far bolder project was begun, in the drilling of a long tunnel through the hills, forming the old crater wall in which Lyttleton harbour is situated. At that epoch this was a unique project. For one thing, it was the first time that an actual crater had been pierced, and great interest in the boring was taken all over the scientific world. But a more important consideration, as far as the work itself was concerned, was the extreme hardness of the rocks encountered, which turned the edge of all varieties of steel tried by the contractors. So serious was this trouble that the latter, a well-known English firm, relinquished the work, and for a time it threatened to remain permanently at this early stage. However, a representative was sent to England, who succeeded in placing



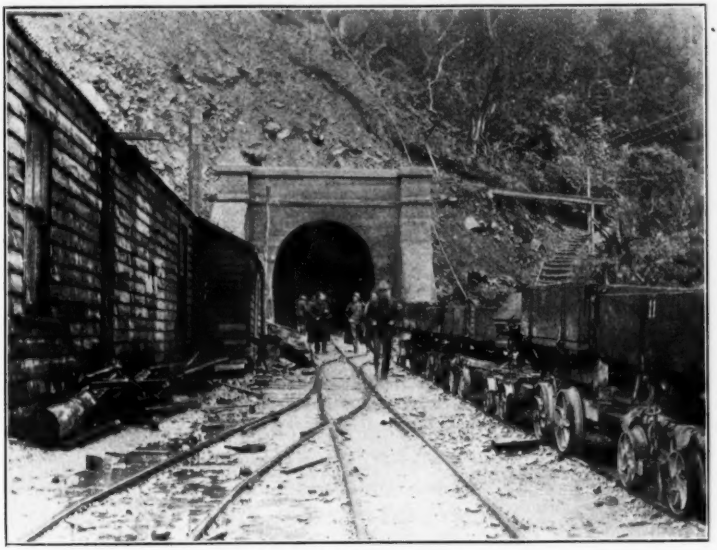
STRIPPING WITH PICK AND SHOVEL FOR THE EASTERN FACE, OTIRA TUNNEL.

the steel manufacturers on their mettle, with the result that a suitable product was supplied. Drilling was again begun, this time by a local firm, and the 1⅝ miles were completed in 1869. The Canterbury government subsequently extended their system which had a 5-foot 3-inch gauge, to a total extent of about 60 miles, when the provinces were amalgamated, in 1876, and the newly formed Central govrnment decided to reduce this gauge to the more economical one of 3 feet 6 inches.

The Otira tunnel, at present being constructed through the Southern Alps about 80 miles west of its forerunner, has the distinction of being at present the fifth longest in the world, and is the crowning achievement in a line of unusual difficulty. The mountain section of this railway during which the ranges are negotiated, is of about 65 miles in extent, and is just nearing completion after a vigourous contention with a multitude of difficulties. In particular, the 10 miles in which the Waimakariri gorge and that of its tributary, the Broken River, are followed, included a whole host of problems. There are, in this brief stretch of line, five big viaducts ranging from 110 to 236 feet in height. Seventeen tunnels of 8 to 30 chains, and a tremendous amount of heavy earthwork, besides smaller bridges and culverts.

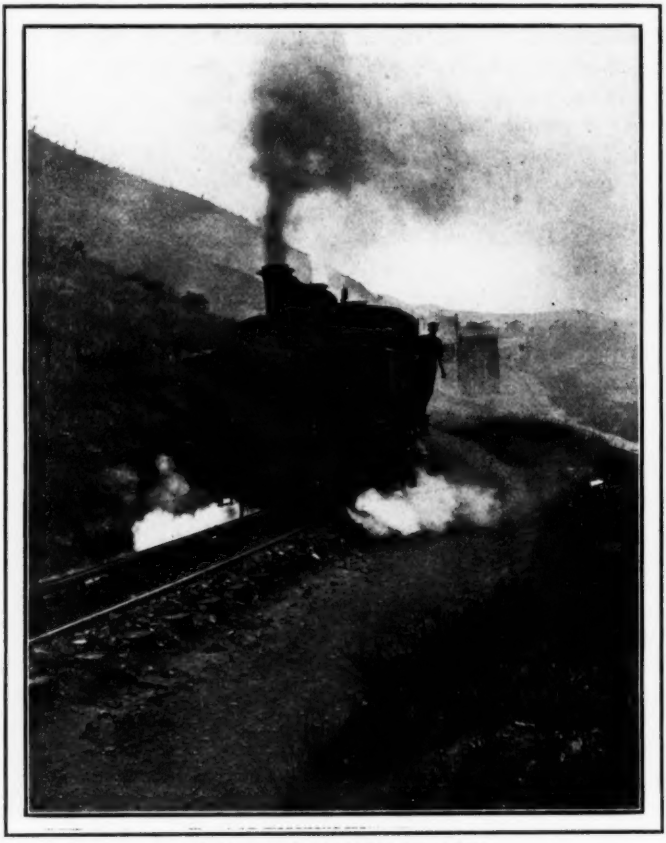
At the summit occurs the Otira Tunnel of 5 miles, 25 chains, making its way through the heart of the range beneath the famous Otira gorge. A local firm is at work upon it, and hopes to complete it within five years, of which three have now gone, at a contract price of £600,000. The eastern end is the highest point of the line, being 2,435 feet above sea level, and from there a grade of 1 in 33 takes the tunnel down to the western portal, 1,585 feet above the sea. Pneumatic percussion drills are employed on the sandy slates encountered, and a total progress of between 120 and 170 feet per week is made. Power is supplied by two hydroelectric stations of 600 horse-power each, and at the present time all is working steadily.

A radically different solution to a similar problem has been carried out in the crossing of the Rimutaka range by the main line connecting Wellington with Napier and the thriving towns of the Wairarapa district, in the North Island. Whichever way the surveyors sought to take the railway, this great obstacle blocked the path. One especially weak place, however, was found in the Rochfort Saddle, 1,448 feet in height; and it was decided that advantage should be taken of this gap. The drilling of a summit tunnel, about half a mile in length, lessened the climb by very nearly 300 feet, but even so, a



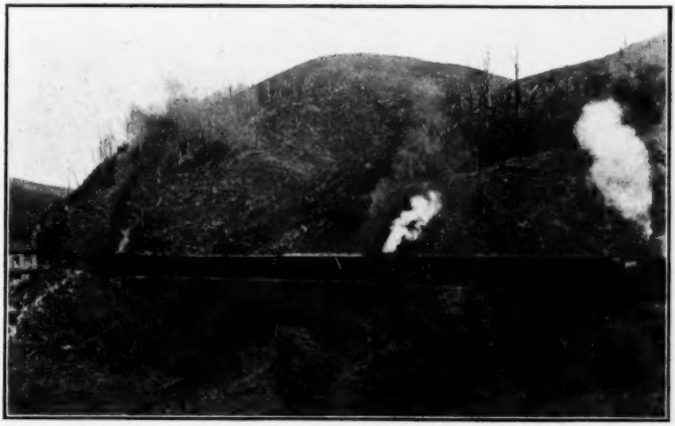
THE OTIRA TUNNEL PORTAL.

grade of 1 in 15 for the 2½-miles descent on the northern slope could not be mitigated by any practicable means. After a consideration of the various methods for climbing such an incline, the Fell system was chosen, and since the opening of the line in about 1880, it has smoothly and satisfactorily performed the heavy duty entrusted to it.



A FELL ENGINE, RIMUTAKA INCLINE.

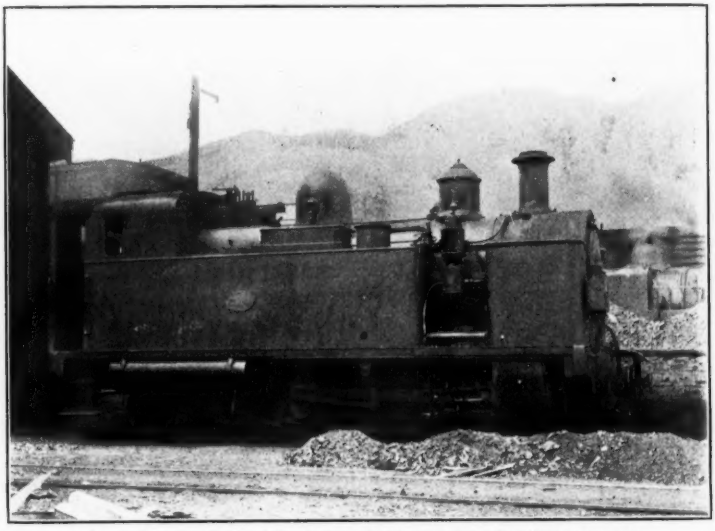
A brief description of the Fell system may here be given, as at the present time no well-known example other than the Rimutaka line is in existence. Its invention and first appearance were due to the advisability of establishing a temporary connection between the rail-heads at either extremity of the Mont Cenis tunnel, when it seemed



A TRAIN DRAWN BY THREE FELL ENGINES CLIMBING THE RIMUTAKA INCLINE.

probable that the slow process of drilling then in vogue would delay the completion for about 25 years. Accordingly, a railway was designed by Mr. Fell, and built, leading over the great Echelle above the tunnel. It fulfilled its duties in the most satisfactory manner until the permanent line through the mountain was opened in 1871. The system consists in the provision of a "grip" rail, midway between those forming the track, and raised some 4 or 8 inches above them. Inside the framing of the locomotives is a secondary engine, operating special small driving wheels which can be compressed against the sides of the third rail. Slipping is thus done away with, and the required degree of tractive force obtained. The third rail is also used for braking, large iron shoes being closed upon it both by the locomotives and also by special brake-vans included in the train. In one trip down the incline, the iron brake blocks are often worn completely through, and the refitting of these at every passage is one of the incidental duties of the large staff of men kept busy at the foot of the hill.

The grip rail is composed, as can be made out from the illustration, of an ordinary double-headed track-rail supported sideways on chairs attached to the sleepers. In addition to its normal functions, it is also valuable in steadying the engines round the sharp corners of the descent. The older engine equipment consists of six Fell, or H class locomotives, of the type shown opposite. They weigh 39 tons, and have a tractive power of 21,320 pounds. In making up the train,



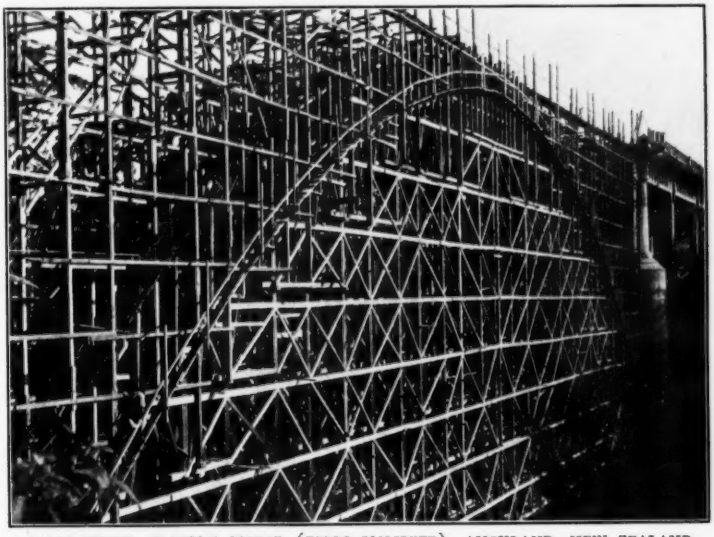
AN H CLASS ENGINE, RIMUTAKA INCLINE, NEW ZEALAND RAILWAY.

an engine is used to every three or four carriages, so that an extra heavy load may demand no less than five locomotives. About fifty minutes are consumed in climbing the hill, giving a speed of only about three miles per hour.

A new and most interesting type of engine has lately been added to the stock at the incline, working upon the ordinary principle of simple adhesion. It is of the 2-6-6-0 type, with separate cylinders on each set of driving wheels. The boiler pressure is 200 pounds, as compared with 140 pounds in the case of the H, and the cylinders are of the Vauclain compound type. There are therefore eight altogether, and they can all be supplied with high-pressure steam for emergencies. The total weight is 65 tons, 17 hundredweight, and the normal tractive power is 24,200 pounds. A specially interesting feature is the use of a circular firebox of corrugated steel. This engine, known as an "E" in the N. Z. R. classification, has worked well ever since its completion in 1905.

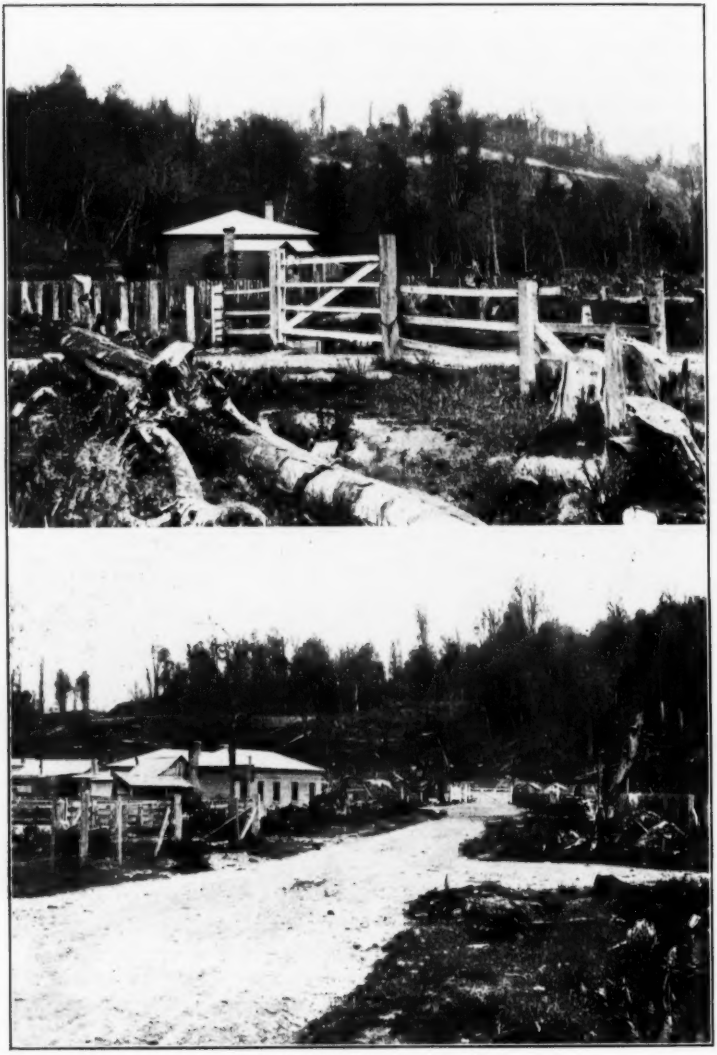
On a larger scale than any of the above mentioned lines is the Main Trunk Railway of the North Island, which, about two years ago, first established communication through the rugged uplands of the almost untrodden King Country. From Wellington to Auckland its

total length is 425 miles, but the most difficult portion occurs between Marton and Frankton Junctions, roughly 100 miles from each end. In this stretch of about 225 miles, the line twice crosses ridges of over 2,660 feet above sea level, hairpin curves and a spiral being required to keep the grade down to 2 per cent, the maximum adopted. A large number of great viaducts occur, the highest being that over the Makatote gorge, in which the track is 260 feet above the river-bed. Tunnels are not by any means frequent, when we consider the mountainous nature of the country. Much heavy work, however, has been put into cuttings, the track in many places ascending or descending from one level to another by a shelving cut out of the hillside. Much of the line penetrates dense forest, and often beautiful gorges are followed for considerable distances. Consequently, the scenery is frequently most charming, and the spice of adventure introduced by the crossing of spidery viaducts far above the serpentine waters of the rivers below, unites to make the journey an enjoyable experience.



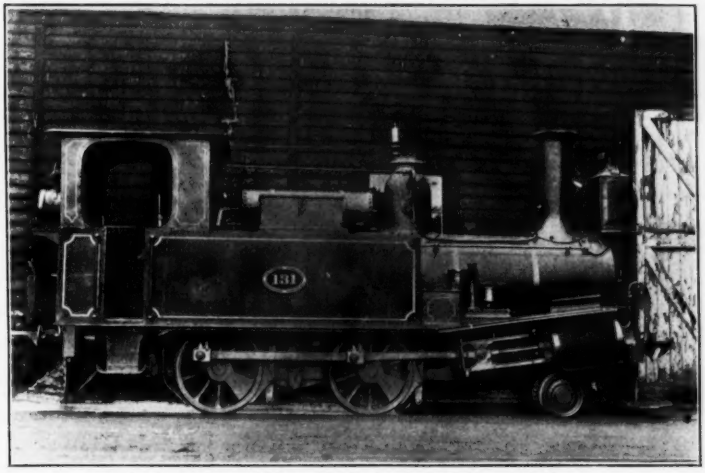
FALSE WORK, GRAFTON BRIDGE (FERRO-CONCRETE), AUCKLAND, NEW ZEALAND.
About 400,000 feet of timbering. Span 320 feet, height about 150 feet. Local cement used.

Without doubt the most interesting features in connection with the Main Trunk Railway are the spiral at Raurimu and the huge compound locomotives that draw the trains over such difficult country. Raurimu is situated at a point where the line, having mounted the steep ascent in the beautiful Whangapapa gorge, reaches a height of



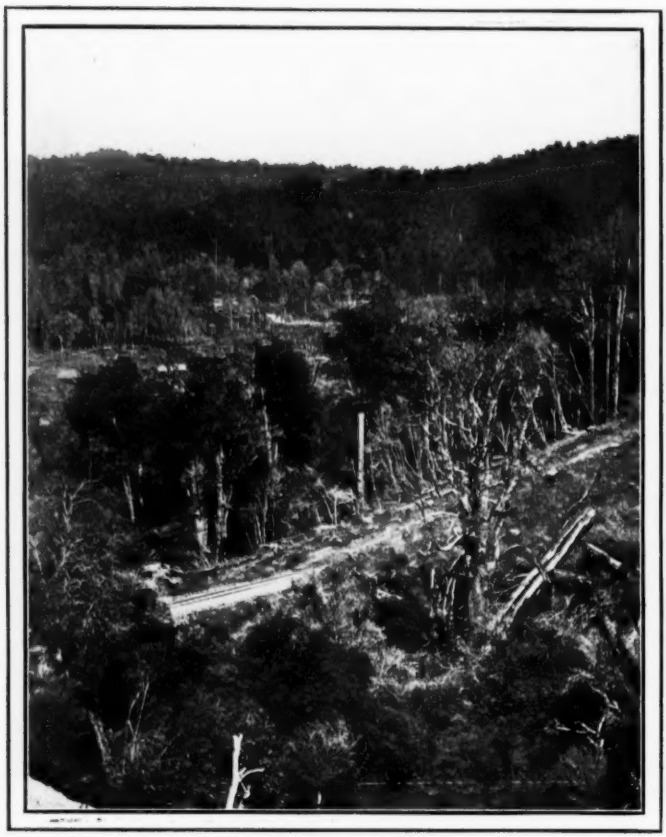
ALONG THE RAURIMU SPIRAL.
The bottom and second levels cross the lower picture; the top or third level is seen in the upper picture.

1,922 feet, and is confronted with a barrier in the shape of a bush-clad ridge, 435 feet high and only a mile and a quarter distant. To surmount this by a 1 in 50 grade requires nearly 4½ miles of tortuous travelling, in the form of a sharp hair-pin curve of one mile in length, which brings the train almost immediately over its starting point and 88 feet higher up; a spiral of roughly a quarter of a mile in diameter, by which a further gain of 75 feet accrues, together with other snake-like windings about the sides of the Piopiotea valley. There are thus three levels visible at the one time, and these can all be distinguished in the accompanying photographs, the intervals between the visible points of the line being exactly a mile in each case. Two tunnels occur, the longer, of 19 chains, serving to take the track beneath the portion of the line that crosses it, 75 feet overhead. Passengers derive great entertainment from watching the township appear and reappear, each time further beneath them than previously.



CLASS D SHUNTING ENGINE, NEW ZEALAND RAILWAY.

Two classes of locomotives are used on this line, resembling each other in their general characteristics, but differing in detail according to the work each is designed for. Both are compound engines of the de Glehn type, in which the high-pressure cylinders are inside the frame, driving upon cranks forged in the leading driving axle, and the low-pressure cylinders are outside, and work upon the second pair of driving wheels. For a distance of 175 miles from Auckland and 160 miles from Wellington, class A locomotives (4-6-2) are



THE RAURIMU INCLINE.
Bottom level (in the distance) and second level, taken from the third level.

used, with 4 foot 6 inch driving wheels and a boiler pressure of 225 pounds. The cylinders are 12 inches and 19 inches diameter, respectively, by 22 inches stroke, the total weight is 72 tons 4 hundredweight, and the tractive power is 17,440 pounds, working compound. This class of locomotive is capable of speeds on the level up to 50 miles per hour, with a normal load. Over the intervening 91 miles, which include most of the greater difficulties of the trip, class X engines (4-8-2) are employed, with driving wheels only 3 feet 9 inches in diameter and a working pressure of 250 pounds, almost a

world's record for a locomotive boiler. The weight of these narrow-gauge monsters is 91 tons 15 hundredweight, and they are propelled by cylinders of 13½ inches and 22 inches diameter by 22 inches stroke, giving a tractive power of 29,840 pounds. They are designed for a speed of 25 miles per hour, and can take a heavy train up the spiral at 20 miles per hour. These two classes, as well as the E mentioned before, are of local construction, and are certainly a great credit to the Government railway authorities.

These are the chief of the bold expedients which have been found necessary to connect the various parts of New Zealand by rail. Needless to say, they have involved great expense on the part of the constructors. Railway communication, however, is rightly regarded as a necessity, rather than a luxury, and where heroic measures were unavoidable, these have been fearlessly adopted. The result is a system extending from end to end of this mountainous country, surely an achievement by no means discreditable to a community of less than a million inhabitants.

EUROPEAN LIFT-VALVE ENGINES.

By Warren H. Miller.

Mr. Miller's article this month may be read in immediate sequence with his preceding contribution on the "Locomobile, or Superheated-Steam Unit." It is a brief review of advanced Continental practice which may be of interest to steam engineers, engine builders, or users of motive power and machinery.—THE EDITORS.

IN America the principal objections to the use of superheated steam in large slow-speed horizontal Corliss engines lie in the facts that cylinder oils flash at temperatures of superheated steam between 450 and 580 degrees, and that ordinary soft valve-rod packings are apt to char and harden with these high temperatures. The advantages, however, are undeniable in reducing cylinder condensation, and it seems a pity to have to use one-third more steam than is really necessary simply because of a little cylinder oil and valve-rod packing. While ordinary slide valves, or other established types and the like are out of the question for even moderate degrees of superheat, it is a fact that a specially designed, balanced light piston valve with cast-iron bushings and rings will run for years without lubrication and at 587 degrees of superheat, as witness the Wolf locomobile units using this valve. But, since as far back as 1873, European engineers have been experimenting with what is known as the *soupape* or *ventil* gear in France and Germany, which consists essentially in vesting the control of steam distribution in balanced double-seated lift valves, very similar to the Stevens poppet-valve gear, so extensively used in America ferryboat engines. The objectors to this system urge that the valves require frequent re-grinding to remain tight, that any grit under the seat will ruin the edge of the valve, and that they never wear equally all around and so will not stay tight for any length of time. These objections have been removed of late years by more experienced design and construction, and, since 1902, hardly a large engine in Europe on superheated steam is not of one form or another of the lift-valve system.

On entering a moderate sized Continental central station of such engines, one appears at first sight to be in a gas-engine power house. The engines appear to be disproportionately long and their valve gear is driven by eccentrics off a lay-shaft, precisely as with large gas

engines. There is no overhead piping in sight nor any main throttle valve. There are no valve-stem packing glands discoverable, and the valve stems for a 600 horse-power engine are less than ½ inch in diameter. If one is fortunate enough to see an engine being erected, or open for inspection, the interior will be quite as curious. The admission and exhaust valves are mounted in the cylinder heads, which are machined all over the full diameter of the cylinders; steam enters these heads by ports registering with those in the cylinder casing, which is double, the outer being a steam jacket; and both the cylinder ends and piston heads are as highly polished as the walls of the cylinder itself.

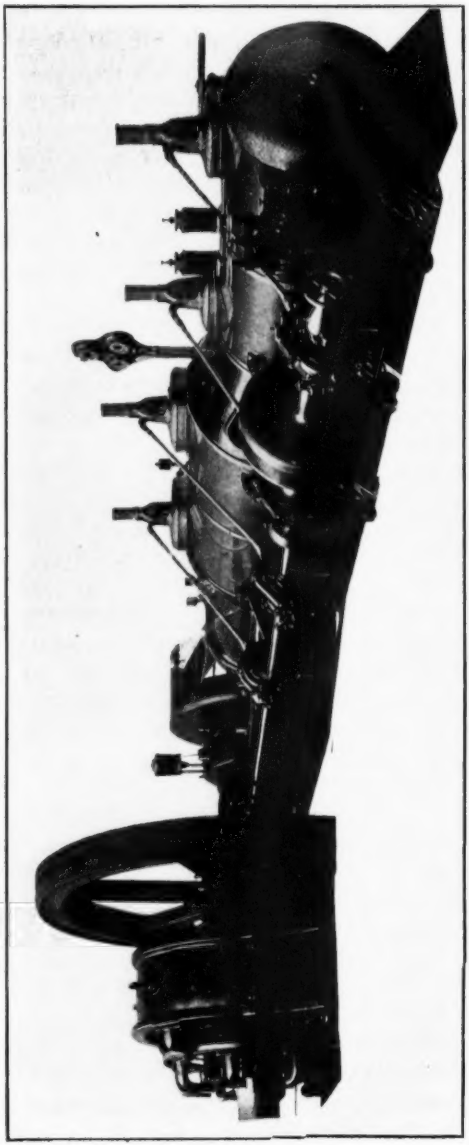
The engines run very quietly and smoothly, with neither click of trip-gear nor snifting of dash-pots, but when they tell one that the steam consumption is between 11 and 12 pounds it is apt to be passed off airily as a mere European exaggeration.

To the American engineer, the first criticism that comes to mind is that all this machine work is very fine, but such an expensively constructed engine would never sell for a moment against his own cheaply designed Corliss trip-gear and four-valve engines. But, if such a criticism were offered to the European engineers, it would probably be met with a query as to the steam consumption of the average American engine. Well, in 300 horse-power sizes, 23 pounds represents good American guarantees on a four-valve engine, and 20 to 17 pounds on a trip-gear. One cannot help thinking that in their minds is running the comment:—"How typically American; to waste so much coal for the sake of building an engine a few dollars cheaper."

But these European steam consumptions are every-day facts. It pays to polish the piston and cylinder heads, because a highly polished surface absorbs much less heat than a rough casting. It pays to jacket both heads and walls of cylinders, because it reduces cylinder condensation. It pays to superheat the steam, because 27 per cent of the steam is otherwise lost in the exhaust, that might have been used in the cylinder.

And, since the ordinary slide-valve and Corliss valves with gland-packed valve stems are not entirely suitable for superheated steam, Europe has gone at the problem in the only logical way and developed a new system of steam distribution called the poppet or ventil gear.

Who builds these engines? Practically every large engine builder in Europe,—Krupp and Augsburg in Germany, Tosi in Italy, Bollinckx in Belgium, Dujardin in France, Brönner in Austria—just to

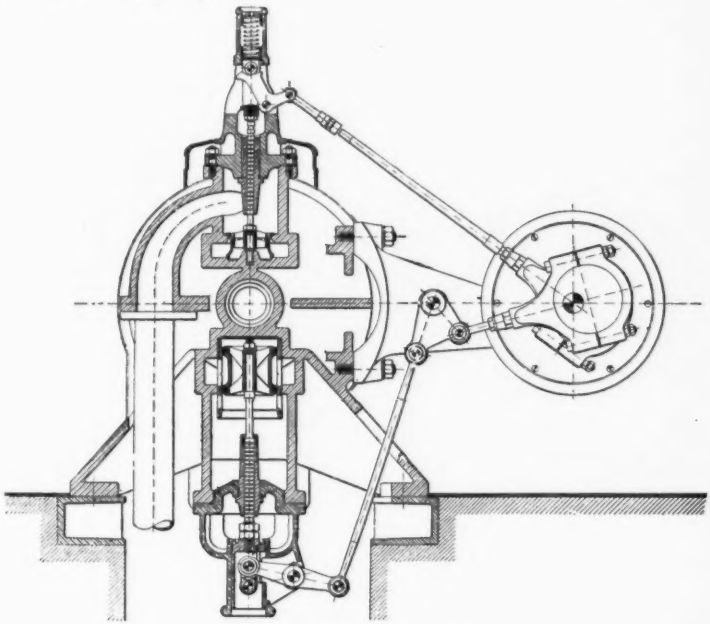


BOLLINCKX STEAM ENGINE WITH LIFT VALVES.

mention one builder in each country. It is fast becoming the standard installation in Europe, for any proposition not pecularly adapted to steam turbines.

The ventil system is simple enough. A small double-seated balanced poppet-valve, actuated by a cam which is driven by an eccentric on the lay shaft for the admission valves; and either piston or lift valves, link-driven by eccentrics on the lay-shaft, for the exhaust. The valve has no sliding friction, whence it requires no lubrication, and is therefore highly suitable for superheated steam. Being balanced, it takes almost no force to operate, and, as there is no shock or jar, the valve being always under the control of the cam, it requires but a very small stem. The best packing for it has been found to be no packing at all. As

will be noted from the section of the valve-gear, the stem is *ground* into the bore of the valve-stem bushing, and labyrinthine rings are cut on the stem which soon fill with oil and condensed steam from the cylinder and are impervious to leakage. Some of the builders provide the stems with a loose steel disc, which condences any wisp of steam that might get through. The construction of the stuffing box is shown on page 197.

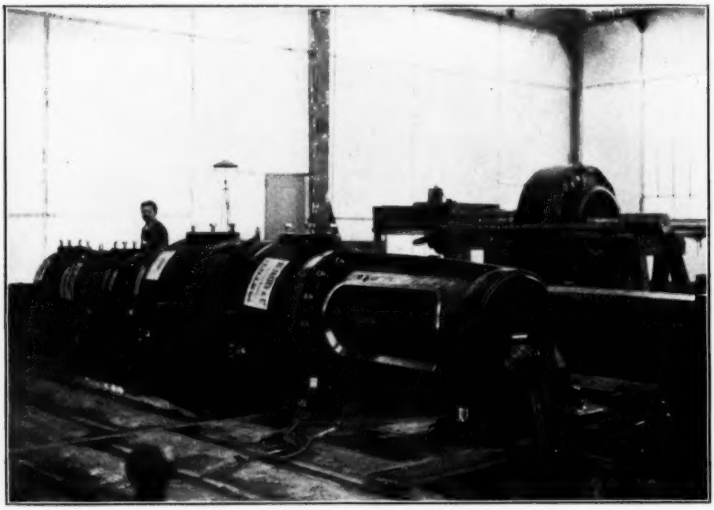


SECTION THROUGH VALVE GEAR.

The cam opens the poppet promptly and cuts off practically with the speed of a trip-gear dash-pot, but arrests the ventil ½ millimeter above its seat, whereupon it is gently deposited on the seat. The total lift to develop the full opening of both lips of the ventil is only 12 millimeters for quite a large engine, which compares strikingly with the travel of a piston-valve for the same opening.

Aside from its advantages in the use of superheated steam, it has the mechanical advantages of doing away with the trips and dash-pots of the Corliss gear, with their frequent adjustments; and of imposing but very little load on the governor, so that the latter can be

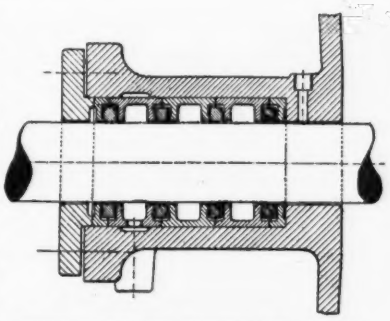
made light and sensitive, as is desirable for instance in the paralleling of polyphase alternators. Furthermore, the valve is opened to full height instantly by the cam, and remains at full height for a greater or less proportion of the stroke, depending upon the governor, so that you get constant port-opening, and therefore wire-drawing and inexact governing are avoided.



CYLINDER OF LIFT-VALVE OR "VENTIL-GEARED" ENGINE, SHOWING VALVE MOUNTING IN CYLINDER HEAD.

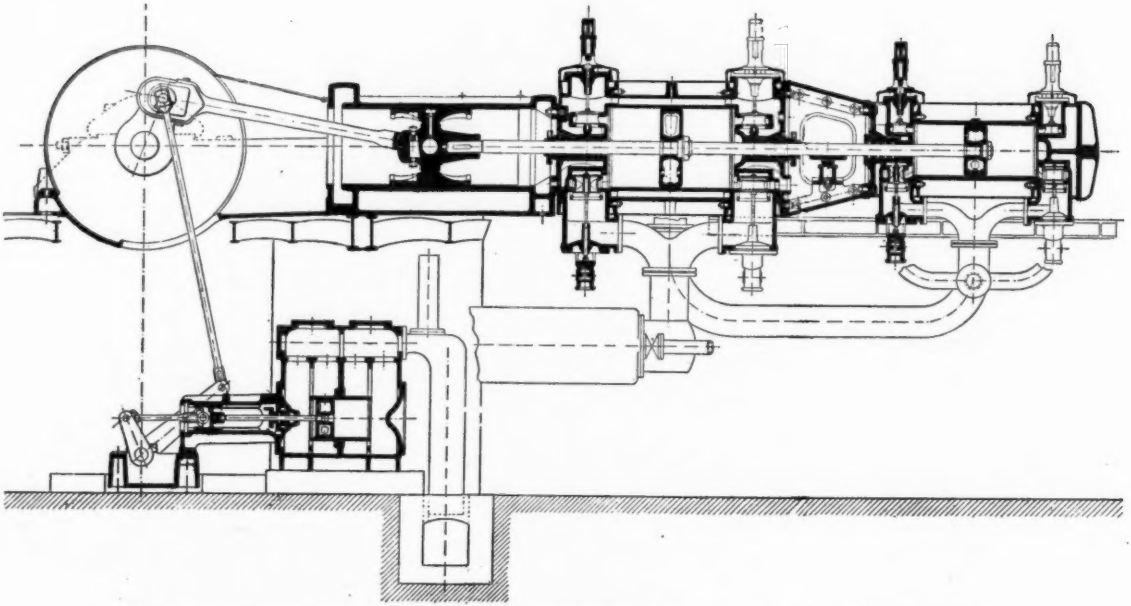
For the exhaust valves the makers vary considerably in preference, some using piston valves and others poppet. The temperature of the exhaust is always low, and there is always plenty of lubrication from the cylinder so that a piston valve can be used without difficulty. The preference for it is mainly because there is a certain amount of dirt and oil impurity in the exhaust, not found in the live steam of the admission, and this dirt is apt to get under the seat of a lift valve and cause it to leak, which possibility is not likely in a piston valve.

Finally, both valves are mounted in the cylinder-head castings, not only to steam-jacket the cylinder ends but to reduce the clearance, because these ventil seats can be placed to open right into the cylinder through wide ports in the heads, thus having less clearance space than any other form of valve gear and permitting the piston virtually to sweep the entire cylinder volume.



STUFFING BOX FOR SUPERHEATED STEAM.

With all large slow-speed steam engines driving polyphase alternators in parallel, some form of inertia governor is essential or otherwise they will be exceedingly prone to "hunt" or over-travel. Change of speed is brought about by an alteration between the load and the driving power. If the load changes, all the various parts of the engine attempt to change speed also, the lighter ones first. But as they are all pinned together by links, pins, and cranks, no part can change any faster than the heaviest moving part, which is usually the flywheel. If the governor also is tied up to this mechanism, as is the ordinary ball governor, it will only alter the driving power simultaneously with the change of speed of the entire engine. This will be too late, particularly with alternators in parallel, so that the entire engine will over-travel and change speed too much in proportion to the change in load. This lack of promptitude in the governor causes the well-known "hunting" so troublesome with alternators in parallel in central stations or with rotary converters in the sub-stations. Now, if there is something on the engine *not* pinned to it but only attached by a spring, this will follow its natural impulse and change speed simultaneously with the change of load, its inertia absorbing part of the power of the spring. This form of governor has been extensively employed in the ventil-geared engines with great success in driving polyphase alternators, so that it is possible to run them in parallel without having to consider the distribution of loads on the engines. In the Belgian engine illustrated the inertia governor takes the form of a flywheel mounted on a sleeve on the lay shaft and controlling the throw of the eccentrics of the high-pressure cylinder admission-valve cams. It also forms a casing for the mechanism of the governor, which consists of two centrifugal masses pivotted to a support fixed on the lay shaft. These are connected by links to the flywheel on one side and on the other to a balancing spring. As soon as a change in speed begins to occur (due to a change in load) the inertia of the flywheel absorbs part of the power of the spring, thus permitting the weights to diverge immediately and allowing the flywheel to



SECTIONAL ELEVATION OF A TANDEM ENGINE, CONDENSING, WITH LIFT VALVES OR "VENTIL GEARS."

gain on the lay shaft. It thus alters the throw of the eccentrics and so changes the admission before the main engine gets a chance to make more than a very slight change in speed. This governor gives an ideal condition for paralleling alternators, since the inertia governor is tied to its engine by the spring in much the same way that two alternators are tied together electrically, so that the variations of the one are lost in the resiliency of the other.

The piston-rod packing used in these engines constitutes a new and interesting advance in that problem. It is here that the Continental builders have chosen to introduce the cylinder lubrication. They have also taken advantage of the fact that the cylinder during the exhaust stroke is under the suction of the vacuum. The packing consists of four cast-iron rings pressing lightly against the rod. The housings for those rings form a series of annular chambers which are filled with the incoming cylinder oil from some such pressure lubricating apparatus as a Mollerup lubricator. The steam during the admission stroke forces its way past the first cast-iron ring in small quantities and into the first annular chamber, possibly into the second. During the exhaust stroke it is condensed and returns into the cylinder along with the lubricating oil. This packing is frictionless and in practice the steam never gets beyond the second annular chamber.

All these Continental engines run at about 125 revolutions per minute for large horizontal central-station and mill work. The ventil-type engines were the only ones exhibited at the Brussels World Exposition this year, every big maker having a specimen of about 500 horse-power on the floor.

But the high-speed engine always has a special field of its own from which it cannot be displaced, and so, to meet the demands for a high-speed ventil-geared engine, the double-ventil system known as the "Lentz" was devised and extensively adopted by German, Belgian and French manufacturers. This system works very well on speeds from 200 up to 400 revolutions per minute and has even been applied recently to torpedo-boat engines of 6,500 horse-power, using superheated steam and thus competing successfully with the steam turbine both in weight and performance.

The Lentz system valve-gear is, in effect, two double-seated balanced poppets with the stems projecting towards each other through their respective stuffing boxes, so that the same cam can act alternately on either stem, thus admitting steam to head and crank ends of the cylinder. A similar pair of poppets perform the same office for the exhaust, while both cams are actuated by the same rock-shaft.

Installation Tested	Dimensions of engine Millimetres H. P. cyl.	L. P. cyl.	Stroke	Steam Pressure Atmospheres	H. P. Developed	Steam Consumption (Sat.) per H. P. hour Kilogram's
Ivan Simonis..... (Verviers)	450	710	900	7.1	200	5.25
Peltzer & Fils.... (Verviers)	760	1150	1500	7.2	690	5.36
Michelin & Co.... (Clermont-Ferrand)	600	940	1200	7.8	315	5.34

STEAM CONSUMPTION OF SOME LIFT-VALVE ENGINES.
Courtesy of H. Bollinckx, Brussels, Belgium.

These valves are placed side-by-side beneath the cylinder, thus making it self-draining, and are driven by an eccentric on the main crank-shaft connected by a light rod to the cam rock-shaft. A little study of the shape of the cam will show that it gives an abrupt rise or descent to the ventil, remaining at full open as long as the circular edge of the cam is in contact. At the end of the descent is an easement which seats the ventil without shock. The greater the throw of the eccentric, the longer will be the time when the valve is full-open.

This fact makes quick and accurate governing very easy to obtain. The governor is simply a very light flywheel inertia governor, much lighter than the corresponding Rites inertia governor for a slide-valve engine of the same size, because the poppets take virtually no power to operate. This flywheel governor advances or retards the position of the eccentric with respect to the position of the cam rock-shaft, thus altering its effective throw and varying the time of admission.

This gear is used both on high-speed stationary engines destined to be run with a separate boiler, and on locomobile units, as in the thousands of installations of the firm of Heinrich Lanz. They make a very smooth and quiet-running engine, and tachometer measurements taken by me on all sorts of fluctuating loads show them to be quite as well adapted for parallel operation as American slide-valve high-speed engines, in addition to which they can easily handle superheated steam at 587 degrees F. and 180 pounds boiler pressure, which American high-speed engines can not.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTS.

By C. E. Knoeppel.

II. THE PRINCIPAL ELEMENTS OF FOUNDRY ACCOUNTING AND MANAGEMENT.

In a preceding article, inaugurating the present series, Mr. Knoeppel outlined the elements of the foundry problem. His article this month discusses thoroughly the very important question of depreciation.—THE EDITORS.

THE statement was made in the previous series on the above subject, that "results of action vary as knowledge increases or decreases," the moral of which is—*know what is going on.* Any industrial undertaking is operated for profit, by men who do not start out with the definite intention of having the venture eventually prove a failure. They expect to be successful and to make money for themselves and for those who may be associated with them in the business. Theoretically, then, there should be no such thing as failures; but the mere fact that each year adds its number of industrial wrecks to the large number that have preceded them, simply emphasizes the fact that action has been the result of a lack of, or the wrong kind of, knowledge. The simple elements of any business, if analyzed and studied, will show how necessary it is, if success and profit is to be attained, to have the *right* kind of knowledge, furnished in the *right* manner, at the *right* time.

Elements must always be recognized before knowledge can be complete. Mathematics would not be mastered in a thousand years if calculus was the starting point, yet it is possible to go into foundry after foundry and find a most hazy idea as regards what constitutes the elements of the business; and where an element is recognized, a great diversity of opinion as to its correct definition is likely to be met with. The purpose of this paper is therefore to pick out, to define, and to attempt as far as possible to reduce to some sort of standard practice, the principal elements entering into the successful operation and management of the foundry, in order that the many possibilities in the two forces discussed in the previous paper—the "analytical" and the "constructive"—may be used to advantage by the foundry manager.

The business of the foundry is to *make castings* and the elements which go to make up the foundry output or production are:—

1. Castings for sale to the trade or to the company of which the foundry is a part, or to both, which we will term "Commercial Production."

2. Castings for the use of the foundry itself, which we will term "Shop-Use Production."

If we attempt to analyze these elements, we shall find that the first is one that is easily understood, as it includes only such castings as will produce a direct revenue on which a profit or loss is made. The second is made up of several other elements which can be picked out and defined, if consideration is given to the following:

While the definite aim of the foundry management is to make and to sell as much as possible, every foundryman is confronted with the necessity of periodically replacing or renewing or repairing certain parts of his plant and its equipment, which leads us to the statement; in order to produce to advantage, we must *maintain* that which makes our production possible. We have still another consideration. The ambition of every foundryman is constantly to increase his volume of production, and depending upon his success in realizing his ambition, we find that he is forced to add new equipment, to build additions, and in other ways to place himself in position to supply his trade with their requirements. This gives us the thought—to expand so as to produce more, it is necessary to *construct* that which will make a greater production and an increased volume of sales possible. This construction is of two kinds, although this fact is not generally recognized, the distinction being determined by the consideration whether the construction is something *altogether new* or simply *the changing of something that has already existed.* We will term these two kinds, A—New Construction, and B—Reconstruction.

In every foundry it is necessary to do special work for customers, as, for instance, making new patterns, replacing or repairing their patterns, or making special rigging for their work, for which a price is charged—another element which we must consider. Still another is made up of such items as cannot be classed with any of the elements which have just been pointed out, and as consideration will show that such an element could not be classed as a revenue-producing or an asset element, it must be classified as expense. Our division of foundry endeavor, common to all foundries, would therefore be as follows:—

1. Commercial Production.
2. Maintenance.
3. Construction—
   - A New Construction.
   - B Reconstruction.
4. Special Work Chargeable to Customers.
5. Expense.

After the principal elements have been pointed out, the task of next importance is to have them intelligently control the numberless details that are met with in the foundry, which must be switched onto one or more of the five main tracks mentioned. In the South Terminal Station in Boston, there are twenty-eight tracks which are connected with the outer network of tracks by switches, and upon the correctness with which these switches are manipulated by the operators depends the safety of hundreds of passenger trains which enter and leave this station daily. There would be absolutely no excuse for an operator to make the statement that he was not sure which one of the twenty-eight tracks a certain train was to enter upon. Likewise, it is just as necessary, in order to prevent costly mistakes, false impressions, dangerous conclusions, etc., to switch the details that are met with daily onto the right tracks. How little attention has been given to this particular consideration of the subject, however, would be evident to anyone who could have the opportunity of placing together, for comparison, the handling of the details in a hundred foundries. It is safe to say that the variety would be most surprising and would be one means of showing why the everyday foundry competition is so inefficient.

The much discussed topic "depreciation" plays such an important part in the proper understanding of the elementary factors of the foundry business that it was deemed advisable to take up the discussion of this subject somewhat in detail.

Keister, an authority on corporation accounting, defines depreciation as:—

> The actual loss upon assets which are diminishing in value, or an estimated sum charged against gross revenue, which amount is considered sufficient to replace the capital used up or reduced by wear and tear.

L. S. Randolph, in a recent paper in this magazine, defines it as follows:—

> The fall in value from any cause whatever, the essential element being that the machine or structure becomes obsolete.

In other words, the common understanding of the subject seems to be that depreciation is:—

The provision made to maintain the book value of an item on a level with the diminishing value of the item, due to its usage or other reasons.

It must be an intensely optimistic mind that can see no depreciation in what he possesses. Such minds do exist, for the author was once told by a shrewd manager that there was no such thing as depreciation; that as long as he kept whatever he had in good condition, it was as good as the day he purchased it and therefore worth what had been expended for it. A foundryman, citing the tumbling barrels in his cleaning room as an example, stated that he considered that there was no wear out to them, for whenever staves were broken, he promptly replaced them, which made the barrels as serviceable as ever. Excellent viewpoints, both of them, but in error just the same.

Let us outline a case which will serve as an illustration. Assume for instance that a horse had been purchased for $350 and for a period of years did all that any horse could do, during which time he was fed regularly, shod when necessary, occasionally received a "doctoring up." Eventually, however, on account of the age of the horse, disease, or other reasons, it has to be sold, $50 being all that it will bring, and to take its place another horse has to be purchased, for which a price of $250 is paid. Assuming the consideration had been that the value of the horse did not diminish, in which case no depreciation charge was ever entered, and we find in our assets an item of $350 year in and year out. Finally, when the horse is sold and the new one purchased, we credit the assets for the salvage of $50, but charge it with the $250 expended for the new horse, so that the account stands—

Old horse	$350.00
New horse	250.00
Total	$600.00
Received for old horse	50.00
Balance in account	$550.00
Value of new horse	250.00
Difference	$300.00

Here we have $300 in the assets account for which there is no value whatever. The only thing to do is to write the amount into profit and loss and the executive can say to his stockholders:

> Gentlemen.—I had to sell our old horse and purchase a new one. After just paying $250 for the new horse, I find the value of the old horse still in our assets, so will have to carry it into profit and loss—hence you will have to go into your own pockets this year to pay for the new horse and in addition stand the difference between the value of the old horse less the salvage and the value of the new horse.

Such an explanation would certainly not appeal to the stockholders, in fact their reply would probably be:

> You should not have allowed this replacement and loss to come out of this year. If the decreasing value of the horse had been offset by a depreciation charge and this amount absorbed yearly by our cost of production, our customers would have paid for it the same as they pay for the labor and material which enters into their product. If this had been done, not only would our profit have been about the same during the years we have had the horse, but when the time came to purchase the new one, there would have been enough in reserve to take care of the purchase without calling upon us to do so.

From this statement, two conclusions are forthcoming:—

1. The customers, not the stockholders, should have paid for the horse.

2. By making "cost of production" absorb the cost of the old horse, less the salvage, the expenditure would have been returned to the business.

A study of this leads to the conviction that one phase of the subject which has never received the proper amount of consideration is the fact that *regardless of all questions of replacements, diminishing values, wear and tear and reserves, whatever is produced for commercial use should absorb all that enters into making that production possible,* whether it is the wages paid to the workmen or the cost of the machinery; expenditures for materials used, or what has been spent for erecting buildings. In other words, whatever is produced uses, in some form or other, the various items in the list of assets and should be assessed with its proportion of the cost of these items. The wages paid the driver of the horse we were just discussing is entered every month against the production of the month. Why not some part of the cost of the horse? If the $65 per month paid to the driver should be left out of the consideration, through an error, what a stir would be raised because of the carelessness of some clerk! But what is said if the cost of the horse stays buried in the assets month in and month out?

A foundryman purchases a moulding machine for $1,000, which he promptly proceeds to charge to his assets. He engages a moulder to operate this machine, and immediately the machine and man become a unit in turning out production. The foundryman charges

the wages paid the moulder against the production of the machine, being very careful that the distribution of the labor is as correct as possible. He may be of the opinion, as many foundrymen are, that there is very little depreciation in a foundry—he may believe there is none at all; and as a result, a very small charge for depreciation is entered against the production of man and machine—perhaps nothing. If it is logical to charge wages against the production, it is just as logical to make this production bear its share of the cost of the machine. The only difference existing is the fact that the workman receives his wages weekly at so much per day while *the machine is paid for in advance.*

The analogy existing between man and machine is worthy of mention. Assuming for purposes of comparison that a man contracts, with a concern or its successors, to give it his services for a period of ten years, at $1,500 per year, the entire sum to be paid upon signing the contract, which provides that in case the man is able to continue on for an additional five years, he is to do so for no extra compensation, the man in turn being guaranteed against deductions for sickness, vacations, etc., the concern to waive all claim to any part of the $15,000 in case of the death of the man. What difference is there in the condition when a machine tool is purchased? The builders of the tool contract with the concern wanting the tool, to give it the service of the machine for $15,000, their estimate being that the machine will last ten years with ordinary usage. If the machine lasts fifteen years, no extra amount is forthcoming to the tool builder. If the tool is out of commission for repairs or because there is no work, the concern gets nothing from the tool builder. If the machine wears out before the stipulated ten years, the concern loses, although there would be some salvage in the disposition of the discarded machine, which would not be the case should the workman die—the only point where the comparison does not hold.

The concern might feel justified in taking the stand that there was little or no depreciation as far as the machine was concerned, but what a difference there would be as regards the man. Not one of the 120 months would pass without a charge of $125 being assessed against the business for the month. If the nature of the work was such as to admit of its being distributed to some specific line of production, this would be done; if this were not possible, then it would go into the general expense of conducting the business, but it would be included without question, for would not the contention be that the amount expended for the man is a part of

the direct or indirect cost of production? Most assuredly it would, and rightly so.

Three things could happen to the man—

1.—He might be off sick from time to time, occasionally going away on a vacation (corresponding to a machine being down for repairs or not in operation because of lack of work).

2.—He might die before the ten years are up (corresponding to a machine being discarded before it has given its full measure of usefulness).

3.—He might work for the ten years and then continue for a few years longer (corresponding to the machine lasting longer than anticipated).

As regards No. 1, it is evident that the charge must be made against general expense. In the case No. 2, if the man dies before the stipulated time, there are only two courses open to the concern.

A.—Write the undistributed portion into profit and loss, thereby closing the transaction.

B.—Allow the undistributed portion to be absorbed, year by year, according to the schedule originally mapped out.

In case No. 3, we have the opposite of case No. 2—the man working longer than was expected. As the $15,000 has already been absorbed by the ten years during which he worked, there remains nothing further to absorb, consequently the services of the man from the ten years until he stops are a clear gain to the company.

Substituting buildings, machinery, and general equipment for the man cited in the illustration, we are bound to reach the same conclusions, and, while the comparison is contrary to all reason, it was used because a person interested would see, in comparing man with machine, that the machine would have to be handled in the same manner as the man.

An opposite viewpoint is equally interesting. If the concern could contract for the buildings, all machinery and equipment, etc., on the basis of monthly payments, for the period of years corresponding to the life of the items (assets on a man basis), it is obvious that *there would be no assets at all for the concern would own nothing until full payments had been made.* The procedure would be most simple. The cost of production of each month would absorb the monthly payments on plant, the same as it would absorb wages, cost of material, and the general expenses. When all payments had been made and the concern owned everything free and

clear, it would be found that the production had paid for everything. If the concern had started out with capital to purchase their plant but had contracted as above outlined, it would also be found that the original capital was intact, as during the years, assuming the business to be profitable, the customers had been paying enough to take care of the cost of the production *which included the charges for plant, plus a profit for the stockholders.*

From these two illustrations—opposite in their nature—it is evident that there is such a thing as depreciation, and that, as the cases cited made no reference to reserve for replacements, diminishing values, etc., it would seem logical to make the assertion that these considerations are after all *only side issues* instead of *principal elements* of the subject that have so long been considered as being the reasons why it was necessary to figure depreciation.

I get my friends to advance me enough money to buy land, erect buildings, install machinery, with the view of conducting a foundry business. I solicit business, get orders which I proceed to fill, charging labor, material, expenses against my monthly productions. My friends may know nothing of the foundry business; they may know little about depreciation, diminishing values, reserve for replacements, etc., *but they do know that they want the business to earn what was invested;* and how can a business earn the investment if a proportionate amount is not a part of my production costs? If I fail to do this, I give my customers the benefit of money invested in my business which they are not entitled to, for when the time comes for buildings to be replaced, new machinery installed in place of that which has worn out, etc., I find no funds on hand to do the work with, without going to my friends to "stake" me a second time. If I sell my plant, it would not, on account of its run-down condition, bring anything like what was put into it originally, hence my friends would lose their investment, or at least the greater part of it. If, however, I had added a proportionate amount of my friends' investment to my cost of production, for which my customers would have paid, I would have invested in good securities funds with which to do my replacing; or I could sell out, and return to my friends the money they invested *plus* their share of the sale of the plant.

Production should do more than absorb what has been expended for material, wages and expenses. It should absorb the cost of the real estate, the buildings, the machinery, etc., and until it has done this, the cost of what we produce cannot cover

what we have actually expended. If I pay $1,000 for a moulding machine and it lasts ten years, and I neglect to charge $100 per year for these ten years to my costs of production, then I am out $1,000—and there is no other way of looking at it. Even if the machine lasts twenty years I do not get back my $1,000, for if my customers fail to pay me for it, who will? The same with everything else, from an expensive building to the horse in the stable.

My theory of depreciation is therefore:—

"The absorption by production of all capital investments, in proportion to the use of this investment entering into making this production possible, and the consequent insurance of a return to the business of the initial expenditure."

This can easily be seen to take care of wear and tear due to usage, diminished value which is the undistributed portion of the costs assessable to future production, reserve for replacements which is the returning to the business what originally was a capital outlay.

As regards the method of figuring depreciation, consideration should be given to the following:—

1.—The estimated life of the unit must be established.

2.—The units must be classified according to those which can be assessed—

A.—Against specific production, as for instance a moulding machine.

B.—Against classes of production, as for instance a building for a certain class of production or the crane in this building.

C.—Against total production, as for instance a crane serving the whole shop or the cupola, fan, charging appliances, etc.

3.—For 2A, a rate per hour should be ascertained which can be charged to specific production when the unit is in use, or to general expense when idle. For 2B and 2C, a rate per month can be established which can be assessed according to the facts in the case.

In establishing these rates we can proceed as follows:—Let

M—Estimated life of the unit in months.

H—Estimated life of the unit in hours.

C—Cost of the unit.

I—Cost of installing the unit.

I_1—Interest on the cost of the unit.

S—Possible salvage upon being declared obsolete.

RH—Rate of depreciation per hour.

RM—Rate of depreciation per month.

Using these symbols, we may then formulate the monthly and hourly depreciation rates thus:

Rule 1.

$$\frac{(C + I + I_1) - S}{M} = RM$$

Rule 2.

$$\frac{(C + I + I_1) - S}{H} = RH$$

Regarding the recording of depreciation charges, a first thought would be that the clerical labor involved in keeping an accurate record of depreciation renders a careful accounting impractical. To keep properly informed as to existing conditions; to have production costs absorb capital charges equitably, it is necessary to keep some track of the items; and while the work may seem unnecessary and like too much "red tape," it will be found profitable. The card illustrated on page 211 would serve as an excellent means of keeping track of values, the reverse side being ruled to show the maintenance cost, date, order number, and the value of repairs. Reserve accounts should be opened for depreciation charges, which should be classified according to

Reserve for Buildings and Real Estate.
Reserve for Plant Equipment.
Reserve for Power and Transmission Machinery.
Reserve for Flasks.
Reserve for Patterns and Drawings.
Reserve for Stable Equipment.
Reserve for Office Equipment.

To these should be credited the amounts charged expense for the depreciation, as shown by a recapitulation of the cards illustrated. In this manner the original values of the asset items are left intact, being offset by these credits to the reserve accounts.

In closing this paper, a few words should be said with further reference to a procedure for asset items declared obsolete before their estimated life, or lasting longer than anticipated. As was stated, two courses are open; either to close the transaction or to allow it to work itself out. It would seem that the former would be the best method of procedure. A contrary opinion by H. C. Bentley, C. P. A., an authority on accounting practice, is as follows:—

Department					Account					
No.		Name of Unit			Estimated Life					
Made by Purchased from			Date		Order No.		Rate of Depreciation			
Date Installed		Original Cost			Interest		Installation		Total Cost	
Betterments					Depreciation					
Date	Order No.	Item	Value	Total	Date	Amount	Balance	Date	Amount	Balance

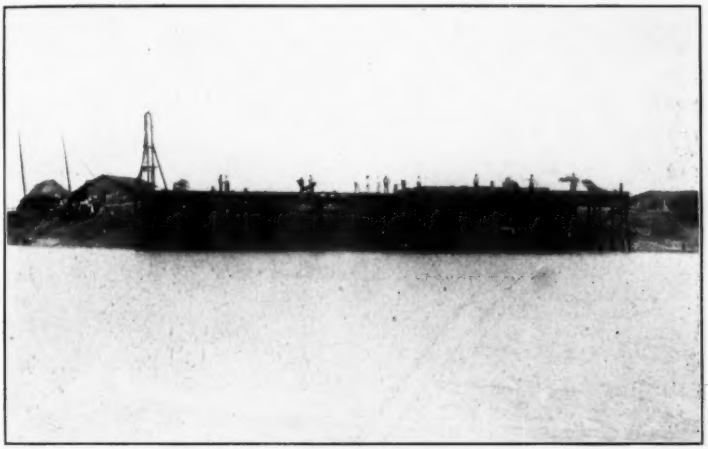
FORM FOR RECORD OF DEPRECIATION.

If ten per centum per annum of machinery and equipment is reserved for depreciation and a machine is replaced three years from the date purchased, it would be theoretically correct to charge the reserve account with only thirty per centum of its cost, as this is the amount reserve has been credited on account of this particular machine. This would necessitate charging "Surplus" with the remaining seventy per centum. It it not advisable to put this theory into effect, however, as some machines will last much longer than the ten years while others must be replaced in much less time than ten years. It thus follows that such inconsistencies adjust themselves in the long run, on a basis that is quite as equitable as if an elaborate method were operated with a view of securing more accurate results.

In the illustration cited by Bentley, $7,000 would be the loss in the year in which the transaction was closed, if the machine had cost $10,000. Assume for example that another machine, with an estimated life of ten years and costing $10,000, should last fifteen years. At the end of the ten years, the $10,000 would stand as a credit to the reserve for depreciation, with five years ahead of the machine. This would mean that the account should have been credited with $666.67 yearly or $6,667 in the ten years, leaving $3,333 to be absorbed by the years to come. We have the $10,000 in reserve, however—too much under the conditions. If, then, we open a "Values Adjustment Account" and credit it with this $3,333, the value on hand, giving this value to reserve for depreciation through a charge entry, we *reduce* the depreciation credit to $6,667, the

amount it should be. We simply transfer part of the reserve credit, *corresponding to the gain to the company,* from one account to another. Crediting assets and charging "Values Adjustment Account" for the $7,000 loss, leaves an adjustment of $3,667 which we would credit to this account and charge to profit and loss.

To a concern desiring to get at the truth of things this would be the proper procedure, as in this way we recover, on items lasting longer than anticipated, a portion of the values in depreciation reserves which can be used to assist in taking care of the losses due to units declared obsolete before the expiration of their estimated life.



TEMPORARY WHARF, AGUA DULCE, NOW REPLACED BY CONCRETE AND STEEL. PROVINCE OF COCLÉ.

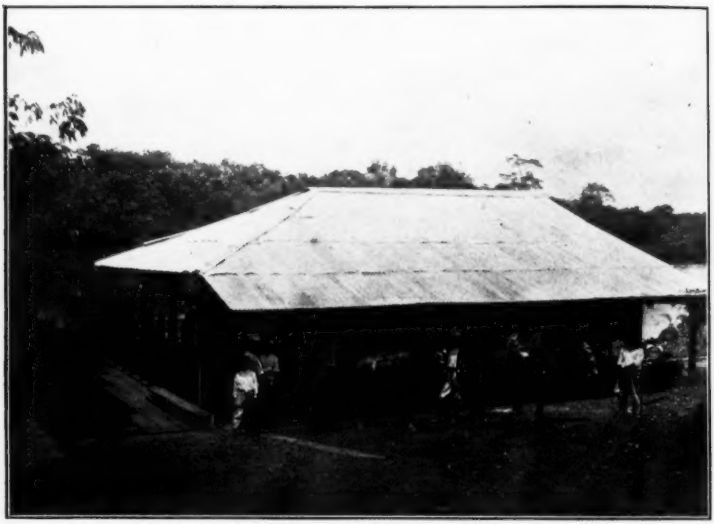
THE DEVELOPMENT OF PANAMA BY PUBLIC ROADS.

By Edward Perry.

The occupation and productive stimulation of new regions, as suggested in the introduction to Mr. Wilson's article elsewhere in this issue, is always interesting to an industrial nation. The development of Panama should have special significance for the manufactures and commerce of the United States.—THE EDITORS.

AS a whole Panama is practically a long, bent and broken range of hills of no great height—the higher of them, however, reaching from 5,000 to over 7,500 feet above the level of the sea. From the border line of the republic of Colombia the new republic runs westward some 430 miles to Costa Rica. In its widest part it is close to 122 miles on a line running from the Caribbean Sea due south to the Pacific; and a line running due north from the Bay of Panama to the San Blas Gulf would be little or no more than 33 miles long from ocean to ocean.

On the north coast are the city of Colon and the village of Bocas del Toro, with a few widely separated hamlets where short streams flow over sandy, shallow and shifting bars into the sea. On the south side of the country swift streams run from the hills near by, to empty into estuaries or directly into the Pacific. In these rivers, estuaries, and bays steamers, schooners, and sloops—many of the latter mere



WHERE RIVER AND ROAD TRANSPORTATION MEET.
Landing at Barranco Colorado, Rio San Pablo, on the road to Sona, Province of Veraguas.

dugout canoes—make fast to the banks and put ashore freight and passengers, and take on board produce and other passengers for Panama city, which is the greatest of all the markets in the country.

Beginning at the eightieth degree of longitude and extending to 81 degrees west, and from 7 degrees 13 minutes north to 8 degrees north, is a peninsula which has a coast line of not far from 200 miles. On the eastern coast are a number of rivers, all short and some of them used by small craft. On the southern shore are not so many streams, but on the west a good number flow into the Gulf of Montijo, and afford good harbors for vessels of light draft. On this peninsula are quite a number of villages and towns of 200 to 5,000 people. Gold, copper, and iron are mined on this peninsula, and agriculture is somewhat developed. The peninsula is hilly, and has a fair number of cart roads, some of which are now being improved.

Bocas del Toro is the westernmost province of this republic. It has one dominant industry—that of banana growing. In extent and value this exceeds any other one agricultural industry in the country, if it does not equal in value all other branches of agriculture of Panama. South of the province of Bocas del Toro is that of Chiriqui, with a coast line of fully 120 miles along the Pacific, not counting

the shoreline of a number of bays and large estuaries, all of them protected by islands from every gale that blows.

Chiriqui has as much plain or savanna land, perhaps, as may be found in any other two of the provinces, if not indeed as much as is in all the rest of the land. For this reason stock growing flourished there long ago, as it does now, and agriculture had a start. Today a number of coffee estates, a few canefields and other farms, some of them owned by men of northern birth, give support to towns of size. David, capital of the province, is credited with a population of more than 10,000.

Naturally, such roads as are in this republic ran beside the streams, from the landings near the sea up among the fertile hills. On the bottoms and hillsides nearer the ocean the valleys are, of course, wider than those higher up, more thickly occupied, and better developed. Farther up, the hills covered by the mould made by ages of falling vegetation show here and there the home of a farmer, where a thousand farms might well be made. Here grow bananas and beans, cacao and cassava, rice and sugarcane, oranges and mangoes, papayas and pineapples, and many another fruit and crop which might be made far more profitable to the grower and to the nation, if the cost of carriage to market did not equal the selling value in that market. Yet prices of farm products are extremely high in the city of Panama and along the Canal Zone, where more than 52,000 people working for the Isthmian Canal Commission are ready to buy food of this country, but cannot afford to do it, because bad roads make the cost too great.

Last year the Republic of Panama imported, not for people on the Canal Zone but to supply her own people, foods valued at $2,441,389. These foods cost retailers probably more than double the valuation quoted; and most of them, and substitutes for all of them, might better have been grown at home.

Panama has been under control by white men for four hundred years, yet had little or no chance to progress before she became a sovereign nation, a little more than six years ago. Since her declaration of independence she has caused the establishment of a transportation system that gives improved facilities to coastwise traffic, and so has helped greatly to develop business in districts near the natural and the improved ports. That coasting trade is now well able to care for itself, and to promote further development of the country it reaches.

This was easily and quickly done. To help yet more, the Government began to realign old roads, and to lay out new; to grade, drain,

PANAMA ROAD BRIDGES, OLD AND NEW.

Below is shown an old covered bridge on the pack trail between Santiago and San Francisco, Province of Veraguas. Above is a view of the work of demolishing an old bridge over a stream in the same province, for the purpose of replacing it by a concrete structure.

and surface these highways, and to build bridges where fords and ferries had for centuries to some small extent served the people. The roads were in few places better than rough earth roads, muddy in many places during eight months of the year, rutted and rough at all other times. They ran into pack-trails which became mere foot paths higher among the fertile hills. Often the fords were difficult, dangerous, or even impassable for days and sometimes weeks at a time. No agriculture could thrive under such conditions.

Panama needed none to tell her of the deadening effects of bad roads, particularly upon agriculture. If there is any one thing about which she is more determined than about any other, it is to make her roads good as quickly and as completely as she can, that people may be led to come and turn into forms useful to mankind the natural riches of her soil. Last year Panama appropriated $1,297,111.65 for the uses of the Secretaria de Fomento (Department of Interior), with the understanding that a large part of that amount would be spent for improvement of the public highways. During the year $660,946.65 only was spent, the Secretary of the Interior having found it difficult to get a dollar's worth of good results for every dollar spent for the work. It was by no means easy to lay out large sums to advantage before the work and the working forces could be well organized. As first assistant engineer the Secretary, Señor José E. Lefebre, now has R. M. Arango, C. E., formerly of the Isthmian Canal, and the work is going ahead rapidly, although the rainy season is now on.

When Panama became a republic there were no accurate records of the mileage of roads, nor of the number, age, or condition of her bridges. All these data were to be gathered at first hand, by surveys in the field. Her count of roads and bridges, from 1904 to 1908 was as follows:

Provinces.	Mileage.	Bridges.	Values.
Coclé	29.80	8	$126,600
Chiriqui	326.79	34	113,035
Los Santos	45.88	10	58,796
Veraguas	56.92	9	60,300
Totals	459.39	61	$358,731

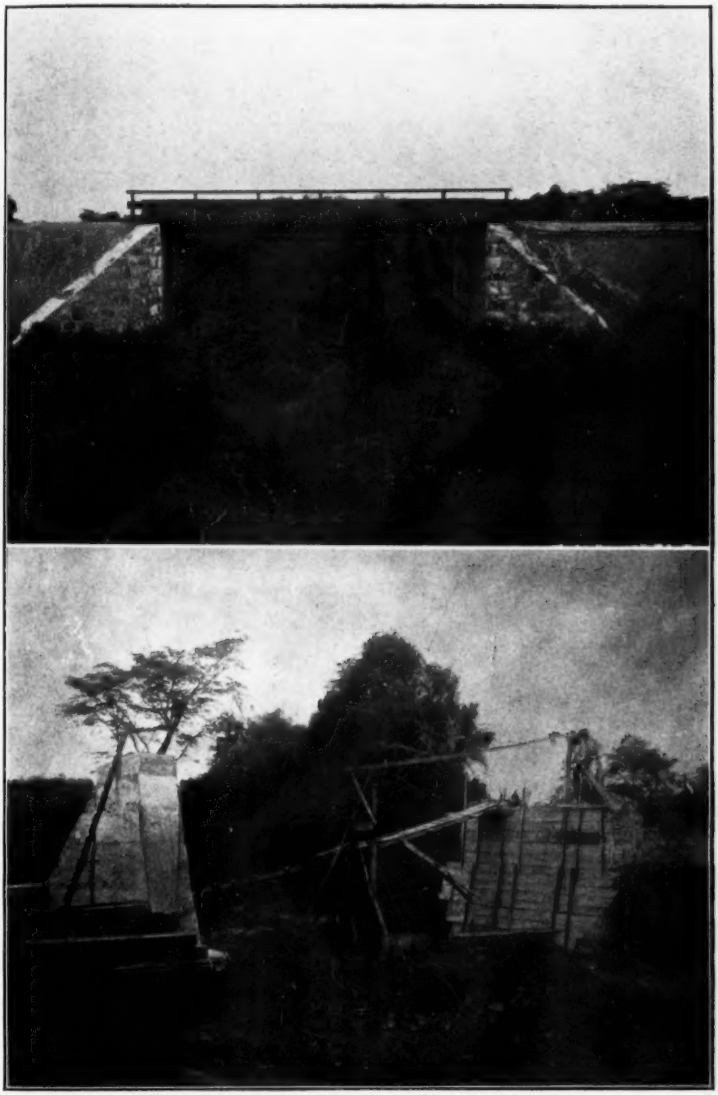
At first the Panamaños, like people of the United States, showed little faith in the value of good roads. They waited to be shown that one could haul on a good road five times as much at a time as he could carry over the roads to which all his people had always been accustomed. Improvements which were to benefit them vastly had

often been promised in the old days, and had never come. Moreover, these people naturally argued that even if new roadbeds should be made they would be of little value so long as the crossing of the streams would be as of old. Therefore few of the owners of property along the lines of proposed improvements were willing to help the work.

TYPE OF SMALL CULVERT, PROVINCE OF VERAGUAS.

But the Secretary of Interior met this condition successfully by building massive culverts and bridges of masonry and of reinforced concrete, before doing much work on the roadbeds between. Then those who would use those roads were quick to see that thorough and lasting improvement would be made and owners along these roads were more than ready to help the work, as most Spanish-Americans are quick to understand and to adopt real improvements.

In all the regions in Panama where road improvement has fairly begun, the people appear eager to help drive this work as fast and as far as means can be provided for doing it. The situation is much as it was in the States, a few years ago, when persistent hammering on this theme of good roads, diligent labor by newspapers and periodicals, by civil engineers, by highway commissioners and commissions, by governors of powerful States, by members of Congress and other men of much influence, roused the people to demand appropriations of the money of the people for this most profitable of investments for the people. But in this young republic of Panama, three or four years has served to do a work which in the States required a quarter of a century.



ROAD BRIDGES IN PANAMA.

Above, a new wooden bridge with stone abutments, on the road between the landing and the town of Agua Dulce, Province of Coclé. Below, concrete abutments for a new bridge between Puerto Mutis and Santiago, Province of Veragues.

This Government is now surveying lines for a railroad which will, in two or three years from this, extend from the Isthmian Canal westward to the city of David, capital of the Province of Chiriqui, and within a few miles of the boundary of Costa Rica. This road will intersect many highways between the Pacific shore and the hills. Naturally, the railroad will be kept above the level of the coastal plains, perhaps well up the hillsides, because there the streams have banks of durable materials, their channels are so steep that floods cannot rise enough to damage the bridges greatly, nor will roadbeds often be flooded.

Those whose places are below this railroad will be able to choose between a short haul up grade to get quick carriage to market, and a haul down grade to a shipping point on the water. At worst the haul cannot be long, for the distance from the railroad to the crest of the highest hill in all that part of the country, cannot be more than a few miles. The average haul to the railroad may be little if any more than four or five miles. The country through which this national railroad, with its many feeders, will lie is naturally of great fertility. It can produce nearly all things grown in northern lands, and all which the tropics can give in the way of harvests.

For four hundred years this country has been under the control of European races; yet it never had a chance to progress in any substantial way before the year 1903, and much of the time since

A ROAD FILL IN A MANGROVE SWAMP, NEAR THE RIVER LANDING OF AGUA DULCE, PROVINCE OF COCLÉ.

NEW ROAD FROM THE LANDING OF AGUA DULCE TO THE TOWN OF COCLÉ.

has been given to learning where improvements would better be done, and what should be done. The present administration is a unit in determination so to use the money Panama has to bring profitable returns, and not to spend it on the mere work of administering the affairs of the nation. The members of this administration agree, without a dissenting word, that agriculture is the first and most urgent need of the country, as it will be its only permanent, secure, and most profitable industry—almost its only sure salvation from disaster when the Isthmian Canal shall be completed and the fifty thousand now working there shall seek other occupation.

The purpose of the Government has been from the beginning, and is now emphatically, to promote agriculture in the ways which shall be best for those who will make farms there; to encourage the firm establishment of a multitude of small farms, such as exist in France, and to discourage the holding of large tracts to the exclusion of thousands of diligent, frugal people who would give that stability and peacefulness which are necessary to lasting prosperity.

To this end Panama offers to each person who wishes it a lot of fifty hectares (247 acres), for $50, or a minute fraction more than 20 cents an acre. If one takes 200 hectares the price will be $55, and if 1,000 hectares the charge will be 95 cents per hectare; 10,000 hectares would cost $5.45 per hectare, and 20,000 hectares would come to $209,000, or $8.46 per acre. Half of the price may

CITY STREETS, TOWN OF BOCAS DEL TORO, PANAMA.
The paving material is coral, much like the coquina of Florida. The municipal buildings are shown in the background of the lower picture.

be paid, with interest at 6 per cent, at the end of a year from the payment of the first half.

Improved wagon roads, the new national railroad, and the Panama canal, will give to her farmers quick and easy transportation to the great markets, at relatively small cost. The canal itself, when the fleets of the world shall be using it, will be a profitable market for much fresh food, and such products can even now be sent by water to all parts of the Pacific shore.

POWER REQUIRED FOR ROLLING STEEL.

By J. A. Knesche.

The data presented in Mr. Knesche's two articles, the first of which was published in our October issue, are the fruit of valuable original investigations. His results and his discussion of them are of great interest and importance to rolling-mill designers and rolling-mill men and to manufacturers of rolling-mill machinery. To give suitable space and form to the figures for permanent reference, the tables are introduced as folding inserts facing page 224, and the formulæ are placed by themselves on this page, so that they may be consulted while the tables are also under the reader's eye.—THE EDITORS.

IN the introduction to the first part of this study, published in the preceding number of THE ENGINEERING MAGAZINE, it was explained that the tests herein discussed were made during 1907, and involved a considerable outlay of money and time in the investigation of the power required to roll steel. In last month's installment the method of testing and the apparatus used were fully described. It remains now in conclusion to present the results of the tests, to analyze them, and to deduce the conclusions established by the experiments.

DISCUSSION OF THE TESTS.

In order to obtain accurate results it is of the utmost importance that correct measurements be obtained of width and height of the steel after each pass. This of course is very difficult in some mills where tests must be made under the usual operating mill conditions. Anyone who has closely watched the process of rolling an ingot in a reversing blooming mill knows from observation that the steel does not always fill the roll-pass, nor is this necessary so far as the proper operation of the mill is concerned. But since in nearly all cases when working up the test the width of the steel is taken from the drawing of the rolls, and the height of the pass from the position of the rolls as shown by the position-indicator of the mill, it is evident that serious errors must be introduced if these dimensions thus obtained are used in arriving at the cross-sectional area. Figure 13 makes this clear. Suppose a 22 by 22 inch ingot receives five passes in C; after the fifth pass it has been reduced to say 12 by 16 inch and it is then entered into pass A. If the steel is edged before entering A, the height of the last pass in C becomes the width of the first pass in A, and since the height in pass A can be determined from the position

Results of the Tests.

In Tables 1, 2, 3, 4 and 5 are given some of the results of my tests, these results having been obtained by the formulæ given below.

Column 1. Direct measurement as described.

" 2. Width x height.

" 3&4. $\frac{\text{Billet volume.}}{\text{Column 2.}}$

" 5. $\frac{\text{Area of preceding pass} - \text{area of pass in question.}}{\text{Area of preceding pass.}}$

" 6. Average foot-pounds of work done for the pass as shown by indicator diagrams.

" 7. Average foot-pounds of work done for interval between passes as shown by indicator diagram.

" 8. Pass plus preceding interval.

" 9. $\frac{w_t\ [V^2 \text{ beginning of pass} - V^2 \text{ end of pass}]}{64.32}$

" 10. $\frac{w_t\ [V^2 \text{ beginning of interval} - V^2 \text{ end of interval}]}{64.32}$

" 11. $\frac{w_t\ [V^2 \text{ end of accelerating period} - V^2 \text{ begin. of pass}]}{64.32}$

" 12. $\frac{w_t\ [V^2 \text{ end of accelerating period} - V^2 \text{ begin. of interv.}]}{64.32}$

" 13. Column 6 + Column 9 or — Column 11.

" 14. Column 7 + Column 10.

" 15. $\frac{\text{Column 13} - [\text{Friction load I. H. P. x 550 x Column 21}]}{[\text{Area preceding Pass} - \text{Area present pass}] \text{ x Column 3 \& 4.}}$

" 16. $\frac{\text{Column 6}}{550 \text{ x Column 21.}}$

" 17. $\frac{\text{Column 7}}{550 \text{ x Column 22.}}$

" 18. $\frac{\text{Column. 8.}}{550 \text{ x (Column 21 + Column 22 preceding)}}$

" 19. $\frac{\text{Column 13.}}{550 \text{ x Column 21}}$

" 20. $\frac{\text{Column 14.}}{550 \text{ x Column 22.}}$

" 21. Chronograph records.

" 22. Chronograph records.

" 23. $\frac{60}{\text{Time in seconds of one revolution just before pass.}}$

" 23. $\frac{60}{\text{Time in seconds of one revolution at end of pass.}}$

Giving Data of Test Conducted on 36 x 48 Inch Single, Non-Condensing Rolling-Mill Engine.

DATA CALCU

Pass No.	Piece. Section. Inches. 1	Area. Sq. In. 2	Length. Ft. 3	Length. Ins. 4	Approx. Reduction. Per Cent. 5	During Pass. Foot Pounds. 6	By Cylinder. Between Passes. Foot Pounds. 7	Total. Foot Pounds. 8	By Fly-Wheel. During Pass. Foot Pounds. 9	Fo
1	4.148 x 2.754	11.423	2	11.00	33.74	48,407	.....	48,407	93,562	
							611,377	.....	.....	
2	4.140 x 1.816	7.518	4	5.25	34.18	48,376	.....	659,753	46,706	
							617,695	.....	.....	
3	4.156 x .785	3.262	10	2.50	56.61	327,719	.....	945,414	728,291	
							657,100	.....	.....	
4	4.180 x .3623	1.514	22	1.25	53.58	227,957	.....	885,057	697,502	
							742,699	.....	.....	
5	4.136 x .2514	1.040	32	.62	31.34	728,435	.....	1,471,134	520,956	
6	4.194 x .1846	.7742	43	.62	25.53	917,714	.....	917,714	.....	
7	4.281 x .1220	.5222	63	9.62	32.54	1,139,430	.....	1,139,430	.....	
						Total.	Total.	Total.	Total.	
						3,438,038	2,628,871	6,066,911	2,187,017	

Friction load at 69.15 R.P.M. 143 I.H.P. Average load 302 actual H.P

Giving Data of Test Conducted on 30 x 72 Inch Single, Non-Condensing Rolling-Mill Engine.

Pass No.	Section. Inches. 1	Area. Sq. In. 2	Length. Ft. 3	Length. Ins. 4	Approx. Reduction. Per Cent. 5	During Pass. Foot Pounds. 6	By Cylinder. Between Passes. Foot Pounds. 7	Total. Foot Pounds. 8	By Fly-Wheel. During Pass. Foot Pounds. 9	Feet.
1	3.145 x 4.00	12.58	2	7.37	19.1	44,323	.....	44,323	68,385	
							399,222	.....	.....	
2	1.776 x 4.25	7.548	4	4.25	40.0	57,815	.....	457,037	161,560	
							236,998	.....	.....	
3	.955 x 4.272	4.079	8	.62	45.9	130,442	.....	367,440	269,533	
							329,973	.....	.....	
4	.2724 x 4.25	1.157	28	4.75	71.6	475,386	.....	805,359	680,630	
							331,007	.....	.....	
5	.2753 x 4.166	1.147	28	7.25	9	456,791	.....	787,798	.....	
6	.1611 x 4.25	.6846	48	.....	40.3	609,496	.....	609,496	111,972	
7	.112 x 4.257	.4768	68	9.62	30.3	655,290	.....	655,290	211,947	
						Total.	Total.	Total.	Total.	
						2,429,543	1,297,200	3,726,743	1,504,027	

Friction load at 45.6 R.P.M. — 123.19 I.H.P. Average load 309 actual

Giving Data of Test Conducted on 36 x 48 Inch Single, Non-Condensing Rolling-Mill Engine.

Pass No.	Section. Inches. 1	Area. Sq. In. 2	Length. Ft. 3	Length. Ins. 4	Approx. Reduction. Per Cent. 5	During Pass. Foot Pounds. 6	By Cylinder. Between Passes. Foot Pounds. 7	Total. Foot Pounds. 8	By Fly-Wheel. During Pass. Foot Pounds. 9	Feet.
1	2.409 x 5.354	12.90	3	3.12	27.7	64,009	.....	64,009	325,300	
							605,992	.....	.....	
2	1.349 x 5.375	7.25	5	9.62	43.7	105,593	.....	711,565	318,794	
							265,046	.....	.....	
3	.807 x 5.387	4.35	9	8.12	40.0	292,340	.....	557,386	.....	
							334,460	.....	.....	
4	.327 x 5.284	1.73	24	3.62	60.2	741,425	.....	774,861	957,900	
							567,130	.....	.....	
5	.2133 x 5.299	1.13	37	2.62	34.6	1,385,134	.....	1,952,264	260,240	
							2,102,282	.....	.....	
6	.1236 x 5.375	.66	63	9.62	41.5	1,972,488	.....	4,075,770	409,878	
						Total.	Total.	Total.	Total.	
						4,560,989	3,874,910	8,135,875	2,721,026	

Friction load at 65 R.P.M. — 157.3 I.H.P. Average load 420 actual H

TABLE 1.

sing Rolling-Mill Engine. Fly-Wheel Diameter—20 Feet. Fly-Wheel Rim—18 1/16 x 12 7/16 In 23 1/16 Inch. Billet Rolled to .122 x 4 9/32 Inch x 63.75 Foot Plate.

Data Calculated From Indicator and Speed Diagrams and Fly-Wheel Data. Work Done. By Fly-Wheel. Total. Foot Pounds. 8	During Pass. Foot Pounds. 9	Between Passes. Foot Pounds. 10	On Fly-Wheel. During Pass. Foot Pounds. 11	Between Passes. Foot Pounds. 12	Actual Total. Including Friction Load. On Billet During Pass. Foot Pounds. 13	Between Passes. Foot Pounds. 14	Constant "C." Work Done on Eac Square Inch of Re duction of Section Per Ft. L'gth of Pie Foot Pounds. 15
48,407	93,562	.....	.....	.....	141,969	.....	5,700
.....	.....	.....	.....	238,023	.....	611,377	.....
659,753	46,706	.....	.....	.....	195,082	.....	8,200
.....	.....	.....	.....	264,220	.....	617,695	.....
945,414	728,291	.....	.....	.....	1,056,010	.....	21,800
.....	.....	.....	.....	916,912	.....	657,100	.....
885,057	697,502	.....	.....	.....	925,459	.....	18,500
.....	.....	.....	.....	600,297	.....	742,699	.....
1,471,134	520,956	.....	.....	.....	1,249,391	.....	63,600
917,714	.....	.....	297,903	.....	619,811	.....	23,200
1,139,430	.....	.....	262,723	.....	876,707	.....	16,800
Total.	Total.	Total.	Total.	Total.	Total.	Total.	Average.
6,066,911	2,187,017	.....	560,626	2,019,452	5,064,429	2,628,871	21,263

erage load 302 actual H.P. Maximum load 1431.78 actual H.P. Average constant "C" 26,300.

TABLE 4.

sing Rolling-Mill Engine. Fly-Wheel Diameter—21 Feet. Fly-Wheel Rim—15 1/4 x 15 1/4 Inches Feet. Billet Rolled to .112 x 4.257 Inch x 68.8 Foot Plate.

44,323	68,385	.....	.....	.....	112,708	.....	9,500
.....	.....	.....	.....	35,991	.....	399,222	.....
457,037	161,560	.....	.....	.....	219,375	.....	7,800
.....	.....	.....	.....	115,971	.....	236,998	.....
367,440	269,533	.....	.....	.....	400,275	.....	11,400
.....	.....	40,000	.....	.....	.....	369,973	.....
805,359	680,630	.....	.....	.....	1,156,016	.....	10,700
.....	.....	.....	.....	134,366	.....	331,007	.....
787,798	.....	.....	197,340	.....	259,451	.....	17,300
609,496	111,972	.....	.....	.....	721,468	.....	19,300
655,290	211,947	.....	.....	.....	867,237	.....	37,600
Total.	Total.	Total.	Total.	Total.	Total.	Total.	Average.
3,726,743	1,504,027	40,000	197,340	286,328	3,736,530	1,337,200	20,600

Average load 309 actual H.P. Maximum load 606.48 actual H. P. Average constant "C" 20,600.

TABLE 5.

sing Rolling-Mill Engine. Fly-Wheel Diameter—24 Feet. Fly-Wheel Rim—16 1/2 x 11 3/8 Inch Feet. Billet Rolled to .1236 x 5.375 Inch x 63.8 Foot Plate.

64,009	325,300	.....	.....	.....	389,309	.....	21,900
.....	.....	.....	.....	156,144	.....	605,902	.....
711,565	318,794	.....	.....	.....	424,387	.....	10,580
.....	.....	.....	.....	162,650	.....	265,046	.....
557,386	.....	.....	.....	.....	741,254	.....	21,100
.....	.....	.....	.....	286,264	.....	334,460	.....
774,861	957,900	.....	.....	.....	1,699,325	.....	21,900
.....	.....	.....	.....	260,240	.....	567,130	.....
1,952,264	260,240	.....	.....	.....	1,645,374	.....	50,350
.....	.....	.....	.....	728,672	.....	2,102,282	.....
4,075,770	409,878	.....	.....	.....	2,382,366	.....	52,200
Total.	Total.			Total.	Total.	Total.	Average.
8,135,875	2,721,026	.....	.....	1,593,970	7,282,015	3,874,910	42,000

verage load 420 actual H.P. Maximum load 1,310 actual H.P. Average constant "C" 42,000.

2 7/16 Inches. Weight of Fly-Wheel Arms—14,700 Pounds. 4 5/8 x 3 3/4 x

tant "C." Done on Each e Inch of Re- n of Section L'gth of Piece. t Pounds.	Average I.H.P. During Pass.	Between Passes.	Total.	Actual H.P. During Pass.	Between Passes.	Test Data. Time. Duration of Pass. Seconds.	Time Between Passes. Seconds.	Rate of R. P. M. Before Pass.	End of Pass.
15	16	17	18	19	20	21	22	23	24
,700	158.76	.....	158.76	465.93	.....	.55	.....	71.95	71.00
....	.....	181.70	.....	.....	151	.....	7.36	.....	.....
,200	130.44	.....	176.61	525.47	.....	.67	.....	73.15	71.85
....	.....	165.50	.....	.....	136.5	.....	8.22	.....	.....
,800	445.55	.....	211.77	1431.78	.....	1.34	.....	74.70	67.50
....	.....	481.99	.....	.....	353	.....	3.48	.....	.....
,500	153.53	.....	324.15	621.36	.....	2.71	.....	75.75	69.60
....	.....	288.47	.....	.....	190	.....	7.08	.....	.....
,600	372.35	.....	320.10	638.09	.....	3.56	.....	75.45	70.25
,200	405.34	.....	405.34	249.60	.....	4.51	.....	70.25	73.00
,800	301.26	.....	301.26	271.01	.....	7.70	.....	73.00	75.45
rage.	Aver.	Aver.	Aver.	Aver.	Aver.	Total.	Total.	Aver.	Aver.
,263	305.04	245.49	277.68	461.26	186.5	21.05	26.14	73.22	72.65

6,300.

/4 Inches. Weight of Fly-Wheel Arms—17,200 Pounds. 3.6 x 4.323 Inch x 2.11

,500	141.31	.....	141.31	358.25	.....	.57	.....	44.11	43.85
....	.....	134.71	.....	.....	137	.....	5.31	.....	.....
,800	152.88	.....	137.04	558.85	.....	.71	.....	44.02	43.25
....	.....	167.67	.....	.....	181.5	.....	2.37	.....	.....
,400	193.32	.....	176.74	606.48	.....	1.20	.....	43.8	42.53
....	.....	218.10	.....	.....	445	.....	1.51	.....	.....
,700	249.10	.....	240.46	537.55	.....	3.91	.....	42.54	39.14
....	.....	215.84	.....	.....	341	.....	1.78	.....	.....
,300	222.96	.....	220.67	125.74	.....	3.75	.....	40.68	40.84
,300	257.08	.....	257.08	304.35	.....	4.31	.....	41.38	40.81
,600	242.26	.....	242.26	325.11	.....	4.85	.....	40.81	39.47
rage.	Aver.	Aver.	Aver.	Aver.	Aver.	Total.	Total.	Aver.	Aver.
,600	233.39	166.47	212.84	357.10	222	19.30	10.97	42.47	41.41

" 20,600.

3/8 Inches. Weight of Fly-Wheel Arms—14,000 Pounds. 3.7 x 4.83 Inch x 2.36

,900	206.77	.....	206.77	1310	.....	.54	.....	70.92	68.35
....	.....	186.97	.....	....	178	.....	5.99	.....	.....
,580	224.86	.....	202.56	856	.....	.90	.....	69.60	68.34
....	.....	239.30	.....	....	241	.....	2.00	.....	.....
,100	313.14	.....	273.42	793	.....	1.70	.....	68.35	64.68
....	.....	319.99	.....	....	231	.....	1.90	.....	.....
,900	377.09	.....	357.33	860	.....	3.59	.....	67.02	63.60
....	.....	387.84	.....	....	396	.....	2.68	.....	.....
,350	415.41	.....	406.70	495	.....	6.04	.....	65.83	63.60
....	.....	279.74	.....	....	280	.....	13.65	.....	.....
,200	405.49	.....	331.27	457	.....	9.48	.....	69.60	61.45
rage.	Aver.	Aver.	Aver.	Aver.	Aver.	Total.	Total.	Aver.	Aver.
,000	384.5	230	324	604	262	22.25	26.22	68.2	63

2,000.

Giving Data of Test Conducted on 36 x 48 Inch. Single, Non-Condensing

Pass No.	Piece. Section. Inches. 1	Area. Sq. In. 2	Length. Ft. 3	Length. Ins. 4	Approx. Reduction. Per Cent. 5	During Pass. Foot Pounds. 6	By Cylinder. Between Passes. Foot Pounds. 7	T Foot
1	1.905 x 13.416	25.558	3	.....	29.62	98,484	.....	98
	.....	.....	..	.....	.....	.....	648,836	....
2	1.171 x 13.520	15.832	4	10.62	38.05	129,048	.....	777
	.....	.....	..	.....	.....	.....	349,502	....
3	.829 x 13.500	11.191	6	11.12	29.31	181,867	.....	530
	.....	.....	..	.....	.....	.....	981,948	....
4	.534 x 13.462	7.172	10	9.62	35.92	438,590	.....	1,420
	.....	.....	..	.....	.....	.....	505,627	....
5	.377 x 13.453	5.078	15	3.00	29.19	782,522	.....	1,288
	.....	.....	..	.....	.....	.....	946,607	....
6	.203 x 13.607	2.769	27	11.50	45.47	1,421,606	.....	2,368
	.....	.....	..	.....	.....	.....	1,393,547	....
7	.160 x 13.576	2.168	35	8.50	21.70	1,421,936	.....	2,815
	.....	.....	..	.....	.....	.....	1,394,326	....
8	.119 x 13.624	1.617	47	11.50	25.41	2,006,119	.....	3,400
	.....	.....	..	.....	.....	.....	1,343,825	....
9	.105 x 13.621	1.426	54	4.25	11.81	2,365,299	.....	3,709
						Total.	Total.	Tot
						8,845,471	7,564,218	16,408

Friction load at 74 R.P.M. — 188.87 I.H.P. Av

Giving Data of Test Conducted on 36 x 48 Inch Single, Non-Condensing

1	1.927 x 22.083	42.554	2	10.50	17.41	31,722	.....	31
	.....	.....	..	.....	.....	.....	331,018	....
2	1.424 x 22.270	31.722	3	10.37	25.45	47,684	.....	378
	.....	.....	..	.....	.....	.....	460,420	....
3	1.404 x 22.083	31.000	3	11.37	2.27	242,008	.....	702
	.....	.....	..	.....	.....	.....	395,407	....
4	1.096 x 22.073	24.198	5	.75	22.26	59,087	.....	454
	.....	.....	..	.....	.....	.....	149,048	....
5	.908 x 22.073	20.044	5	11.75	17.12	112,239	.....	261
	.....	.....	..	.....	.....	.....	1,159,607	....
6	.683 x 22.024	15.038	7	11.50	24.97	134,696	.....	1,294
	.....	.....	..	.....	.....	.....	403,123	....
7	.571 x 22.062	12.446	9	9.62	17.23	713,541	.....	1,116
	.....	.....	..	.....	.....	.....	837,551	....
8	.329 x 22.324	7.347	16	7.87	40.96	605,094	.....	1,442
	.....	.....	..	.....	.....	.....	1,645,332	....
9	.259 x 22.156	5.749	21	3.62	21.74	678,824	.....	2,324
						Total.	Total.	Tot
						2,624,895	5,379,506	8,006

Friction load at 67 R. P. M. — 177 I.H.P. Average

* Probable slight error due to insufficient sensitive

TABLE 2.

ondensing Rolling-Mill Engine. Fly-Wheel Diameter—24 Feet. Fly-Wheel Rim—16 1/2 x 11 3/4 I
Inch. Billet Rolled to .1047 x 13.621 Inch x 54.354 Foot Plate.

DATA CALCULATED FROM INDICATOR AND SPEED DIAGRAMS AND FLY-WHEEL DATA.

nder. en s. nds.	Work Done. By Fly-Wheel. Total. Foot Pounds. 8	During Pass. Foot Pounds. 9	Between Passes. Foot Pounds. 10	On Fly-Wheel. During Pass. Foot Pounds. 11	Between Passes. Foot Pounds. 12	Actual Total. Including Friction Load. On Billet During Pass. Foot Pounds. 13	Between Passes. Foot Pounds. 14	Constant Work Done Square Inch duction of S Per Ft. L'gth Foot Pou 15
..	98,484	309,958	.....	.....	.....	408,442	.....	11,900
36	.....	.....	.....	.....	309,958	.....	648,000	.....
..	777,884	377,365	.....	.....	.....	560,413	.....	9,100
02	.....	.....	54,732	.....	404,234	.....	404,234	.....
..	530,369	225,743	.....	.....	.....	407,610	.....	10,000
48	.....	.....	.....	.....	162,469	.....	981,946	.....
..	1,420,538	453,990	.....	.....	.....	892,580	.....	16,700
27	.....	.....	.....	.....	263,868	.....	505,627	.....
..	1,288,149	223,538	.....	.....	.....	1,006,060	.....	23,600
07	.....	.....	.....	.....	456,871	.....	946,607	.....
..	2,368,213	774,895	.....	.....	.....	2,196,501	.....	26,800
47	.....	.....	.....	.....	698,270	.....	1,393,547	.....
..	2,815,483	59,917	.....	.....	.....	1,481,853	.....	40,700
26	.....	.....	.....	.....	278,847	.....	1,394,326	.....
..	3,400,445	678,681	.....	.....	.....	2,684,800	.....	73,000
25	.....	.....	.....	.....	649,875	.....	1,343,825	.....
..	3,709,115	1,216,787	.....	.....	.....	3,582,086	.....	257,000
l.	Total.	Total.	Total.		Total.	Total.	Total.	Average
18	16,408,680	4,320,874	54,732	.....	3,224,392	13,166,345	7,618,950	41,800

H.P. Average load 628 actual H.P. Maximum load 1,360 actual H.P. Average constant "C" 41,8

TABLE 3.

ndensing Rolling-Mill Engine. Fly-Wheel Diameter—20 Feet. Fly-Wheel Rim—18 1/16 x 12 7/
28.5 Inch. Billet Rolled to .259 x 22.156 Inch x 21.302 Foot. Plate.

..	31,722	253,000	.....	.....	.....	284,722	.....	9,050
18	.....	.....	252,000	.....	.....	.....	583,018	.....
..	378,702	526,000	.....	.....	.....	573,684	.....	12,000
20	.....	.....	.....	.....	433,000	.....	460,420	.....
..	702,428	.....	.....	571,500	.....	329,492	.....	*
07	.....	.....	.....	.....	5,988	.....	395,407	.....
..	454,494	5,988	.....	.....	.....	65,075	.....	*
48	.....	.....	162,424	.....	.....	.....	311,472	.....
..	261,287	553,890	.....	.....	.....	666,129	.....	22,600
07	.....	.....	.....	.....	1,060,000	.....	1,159,607	.....
..	1,294,303	900,000	.....	.....	.....	1,034,696	.....	22,900
23	.....	.....	314,000	.....	.....	.....	717,123	.....
..	1,116,664	170,000	.....	.....	.....	883,841	.....	20,350
51	.....	.....	.....	.....	820,000	.....	837,551	.....
..	1,442,645	861,519	.....	.....	.....	2,466,613	.....	25,750
32	.....	.....	.....	.....	196,000	.....	1,645,332	.....
..	2,324,156	1,253,000	.....	.....	.....	1,931,824	.....	45,300
l.	Total.	Total.	Total.	Total.	Total.	Total.	Total.	Average
06	8,006,401	5,523,397	728,424	571,500	3,514,988	8,235,776	6,107,930	29,450

Average load at 602 actual H.P. Maximum load at 1,558 actual H.P. Average constant "C"
sensitiveness of chronograph and measurement of time.

l Rim—16 1/2 x 11 3/4 Inches. Weight of Fly-Wheel Arms—14,000 Pounds. 2 13/16 x 12 7/8 x 25.41
54 Foot Plate.

Wheel Data.							Test Data.			
							Time.		Rate of R. P. M.	
Total. iction Load. Between Passes. Foot Pounds. 14	Constant "C." Work Done on Each Square Inch of Reduction of Section Per Ft. L'gth of Piece. Foot Pounds. 15	Average I.H.P. During Pass. 16	Between Passes. 17	Total. 18	Actual H.P. During Pass. 19	Between Passes. 20	Duration of Pass. Seconds. 21	Time Between Passes. Seconds. 22	Before Pass. 23	End of Pass. 24
.....	11,900	328.56	.....	328.56	1360.11	.....	.54	.....	73.15	70.50
648,000	.....	.....	299.86	.....	.....	300	.....	3.93	.....	.....
.....	9,100	328.23	.....	304.24	1281.49	.....	.71	.....	73.15	69.95
404,234	.....	.....	401.74	.....	.....	464	.....	1.58	.....	.....
.....	10,000	400.89	.....	401.45	873.63	.....	.82	.....	69.25	67.45
981,946	.....	.....	468.26	.....	.....	746	.....	2.39	.....	.....
.....	16,700	488.31	.....	476.42	990.16	.....	1.63	.....	68.85	64.80
505,627	.....	.....	525.78	.....	.....	526	.....	1.74	.....	.....
.....	23,600	572.40	.....	553.13	721.75	.....	2.48	.....	67.15	65.15
946,607	.....	.....	511.74	.....	.....	612	.....	2.81	.....	.....
.....	26,800	507.08	.....	547.07	878.69	.....	4.54	.....	69.25	62.00
1,393,547	.....	.....	521.97	.....	.....	520	.....	4.84	.....	.....
.....	40,700	438.68	.....	476.31	458.99	.....	5.87	.....	68.50	68.05
1,394,326	.....	.....	322.74	.....	.....	328	.....	7.73	.....	.....
.....	73,000	499.47	.....	408.88	664.14	.....	7.35	.....	70.50	64.20
1,343,825	.....	.....	482.67	.....	.....	480	.....	5.09	.....	.....
.....	257,000?	475.36	.....	478.11	743.48	.....	8.76	.....	70.30	62.15
Total.	Average.	Aver.	Aver.	Aver.	Aver.	Aver.	Total.	Total.	Aver.	Aver.
7,618,950	41,800	426.09	479.05	457.10	782.14	457	32.737	30.123	70.01	64.91

verage constant "C" 41,800.

eel Rim—18 1/16 x 12 7/16 Inches. Weight of Fly-Wheel Arms—14,700 Pounds. 2.349 x 21.937 x
21.302 Foot. Plate.

.....	9,050	125.61	.....	125.61	1128.32	.....	.46	.....	70.50	67.98
583,018	.....	.....	110.95	.....	.....	96.04	.....	5.4	.....	.....
.....	12,000	114.90	.....	111.42	1407.60	.....	.74	.....	65.46	60.18
460,420	.....	.....	460.88	.....	.....	507	.....	1.66	.....	.....
.....	*	605.35	.....	503.04	.....	.....	.73	.....	64.68	70.08
395,407	.....	.....	209.88	.....	.....	208	.....	3.44	.....	.....
.....	*	135.39	.....	194.92	137.78	.....	.86	.....	69.12	67.92
311,472	.....	.....	121.40	.....	.....	277	.....	2.23	.....	.....
.....	22,600	201.42	.....	145.46	1191.83	.....	1.02	.....	66.48	60.84
1,159,607	.....	.....	639.50	.....	.....	618	.....	3.40	.....	.....
.....	22,900	195.21	.....	517.12	1498.88	.....	1.25	.....	71.70	59.94
717,123	.....	.....	284.92	.....	.....	500	.....	2.60	.....	.....
.....	20,350	724.02	.....	506.05	928.57	.....	1.73	.....	63.12	61.44
837,551	.....	.....	365.55	.....	.....	364	.....	4.18	.....	.....
.....	25,750	388.12	.....	374.44	1558.23	.....	2.88	.....	70.14	61.26
1,645,332	.....	.....	606.91	.....	.....	686	.....	4.37	.....	.....
.....	45,300	308.57	.....	460.04	870.59	.....	4.03	.....	72.72	60.60
Total.	Average.	Aver.	Aver.	Aver.	Aver.	Aver.	Total.	Total.	Aver.	Aver.
6,107,930	29,450	347.79	346.44	347.10	1189.45	409	13.69	27.30	68.21	63.70

Average constant "C" 30,400.

indicator, both width and height for the first pass in A become known. But the steel is not edged for every pass in A; it therefore happens that the widening effects in successive passes in A due to rolling are not taken into consideration, or at best can only be estimated. A similar uncertainty will of course occur if the ingot assumes the position indicated in B. It is this uncertainty of the width of the steel after each pass which may introduce large errors; for if the errors be ¼ inch only, and if the steel in the blooming-mill rolls is 16 inches high, as a result of the error there would be a difference of four square inches. But a difference of ½ inch between the actual width and the assumed one may not be uncommon. For the above reasons, in all mills where measurements of width and height of steel cannot be made with micrometer calipers it would be well to devise some method for the rapid and accurate determination of the length of the steel after every pass. Knowing the original weight of the ingot and the accurate length for each pass, the exact cross-sectional area is easily obtained.

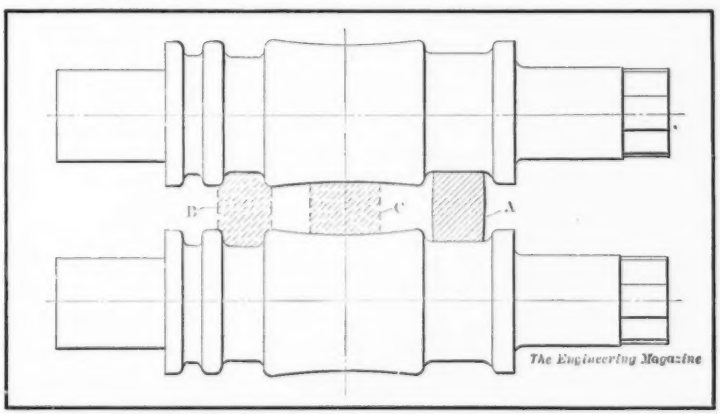


FIGURE 13. SHOWING RELATION BETWEEN ROLL PASSES AND AREA OF INGOT.

When the area is accurately determined once for each pass, the length and the approximate reduction can be determined with equal exactness for each pass in the manner described previously, and thus the denominator of Constant C is found accurately.

The method of finding the work done by the steam in the engine cylinder has been given already and no further comment seems necessary. If first-class instruments are at hand wherewith to take measurements, and if these measurements make clear beyond all doubts

all the indicator diagrams belonging to every pass and to every interval and further, if these measurements show the exact time or duration of every pass and every interval, then the working up of the data will present no difficulty and the results obtained can not help but be accurate. The same is likewise true of the energy given out by the flywheel.

The data in columns 9 in the Tables of the tests show what a very important part the flywheel plays in rolling-mill work. A careful study of these figures soon makes clear that in the comparatively short passes the percentage of flywheel work to the total work is greatest. In Table 3, for instance, the flywheel work done during the first pass is 253,000 foot-pounds, while the steam in the cylinder of the engine did only 31,722 foot-pounds of work. This represents 89 per cent and 11 per cent respectively or these two sources of energy. It should be borne in mind, relatively speaking, that flywheels are of great importance in short passes only; in long passes, or in passes where the engine has not time to come back to its normal speed by reason of forced production, they will create a positive loss in power.

Nothing need be said of the average indicated horse power columns nor of the actual horse power columns as the same data are given in the preceding columns expressed in foot pounds. The actual horse power is the total power required for rolling as computed from the cylinder and the flywheel work.

The rate of revolutions per minute column is interesting. When considered in connection with the time column it shows clearly how quickly the speed of the engine changes during rolling.

Constant C.

In studying Constants C for the different tests it will be noticed that in some cases certain constants are much greater than either the following one or the preceding one. At first I could find no explanation for this, for I reasoned that since the cooling of the steel took place at a practically constant rate, the power required for rolling the steel, or Constant C, should increase likewise at a practically constant rate, because the temperature of the steel rolled was thought to be the only controlling factor in the power requirement in rolling mills. It was my opinion that in the ordinary rolling of a billet or an ingot, as the steel cooled, there would be constantly more power required for Constant C for the successive passes, and therefore Constant C would be found gradually becoming greater. This tendency of actual

increase of Constant C with the cooling of the ingot or billet is evident from the examinations of Constant C in the different tests; but there is not as much steady regularity in the increase of Constant C as one would expect. It was therefore soon evident that there must be some other influence at work which tends to make Constant C higher than the temperature alone could bring about.

When we scrutinize Constants C for the different passes it will be found that those which seem out of place are in nearly all cases for closed passes, i.e., for passes where the steel is surrounded on all sides by the rolls. In the finishing passes where the rolls press only on two surfaces of the steel and where the temperature of the steel has not dropped below a normal of say 1,700 degrees F., Constant C does not appear out of place when compared with the preceding one. In closed passes where the steel is surrounded on all sides by the rolls, the lateral displacement of the steel is preventd by the walls of the pass; in this manner much energy no doubt is lost through friction, the magnitude of which depends on the relative width of roll pass, width of steel entering the pass, and power exerted at the rolls.

In the rolling of structural shapes or rails, for instance, it will no doubt frequently happen that large Constants C are encountered. This will be due to the fact that the shape of the finished product makes necessary deep cuts into the steel at certain stages of the rolling, forcing the metal with great pressure against some surface or surfaces of the roll-pass not parallel to the axes of the rolls.

To what extent all unnecessary friction in the roll-pass may be eliminated and thereby the power requirement for the pass in question be brought down to the smallest figure is a question for the skilful roll-designer to determine. It will no doubt always be the case that Constant C is smaller for flats, squares, and round sections than for structural shapes, rails, etc. From a careful examination of some eighty tests conducted with the greatest possible care, I have come to the conclusion that by paying proper attention to details mentioned in a preceding paragraph the power required for rolling steel may in many cases be reduced 50 per cent and perhaps even more.

If we now take the Constants C and the temperatures during the rolling of the different passes, and plot one as ordinates and the other as abscissæ, we obtain a very interesting curve. Between the proper limits its shape and general direction is similar to the tenacity-temperature curve shown in Figure 12.*

* The Engineering Magazine, October, 1910, page 54.

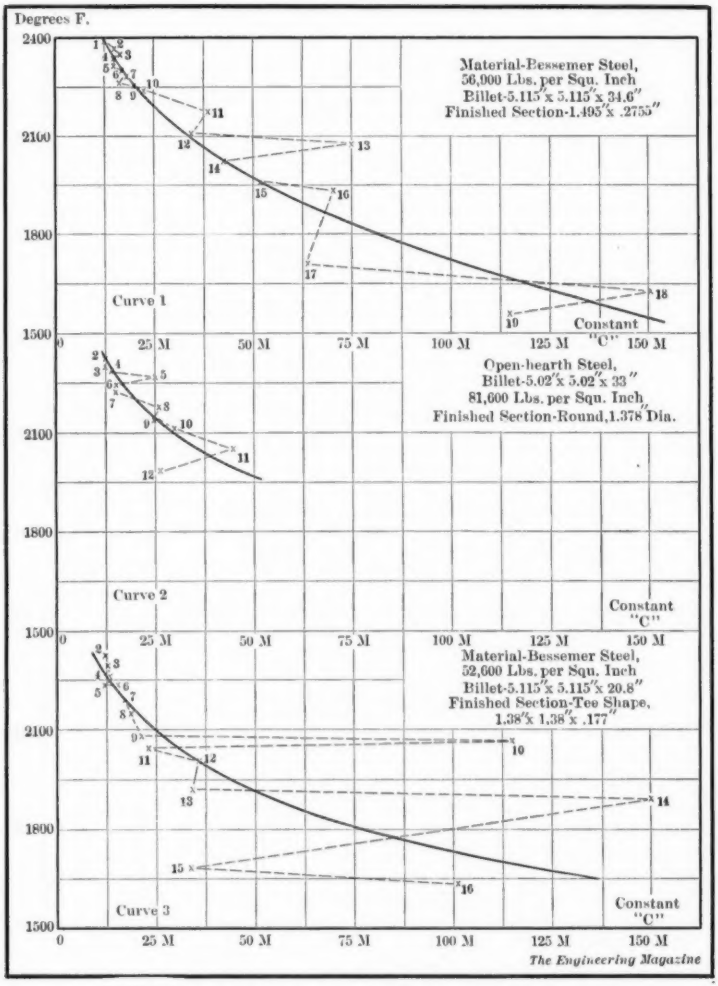


FIGURE 14. CONSTANTS C IN VARIOUS ROLLING-MILL TESTS.

As already stated, the temperatures were not taken during my tests, but in order to show the value and importance of curves previously mentioned for the rolling mill man and the roll-designer, I worked out the Constants C of some of Mr. J. Puppe's rolling-mill tests. These curves are shown in Figures 14, 15 and 16. They show

at a glance the power required for any pass at a certain temperature. That none of these curves can be taken in the accurate determination of the power required for rolling steel will soon appear by a careful study of these different curves which are for flats, rounds, squares, structural shapes, rails and steel ties. The irregularity of sucessive Constants C is evident in these curves in the same manner as in the case of my own tests.

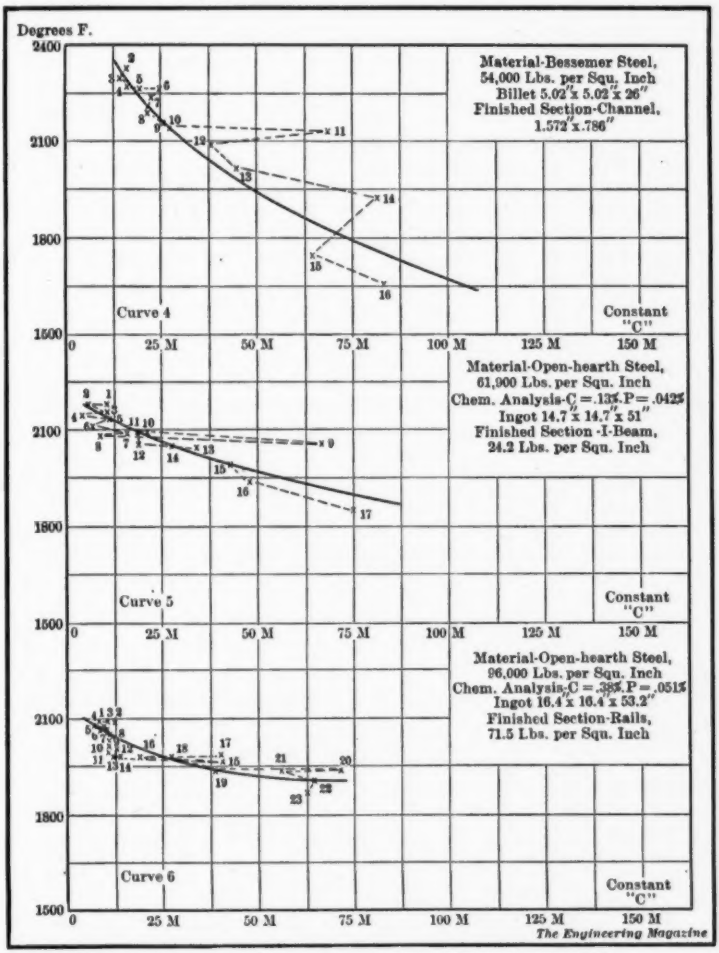


FIGURE 15. CONSTANTS C IN VARIOUS ROLLING-MILL TESTS.

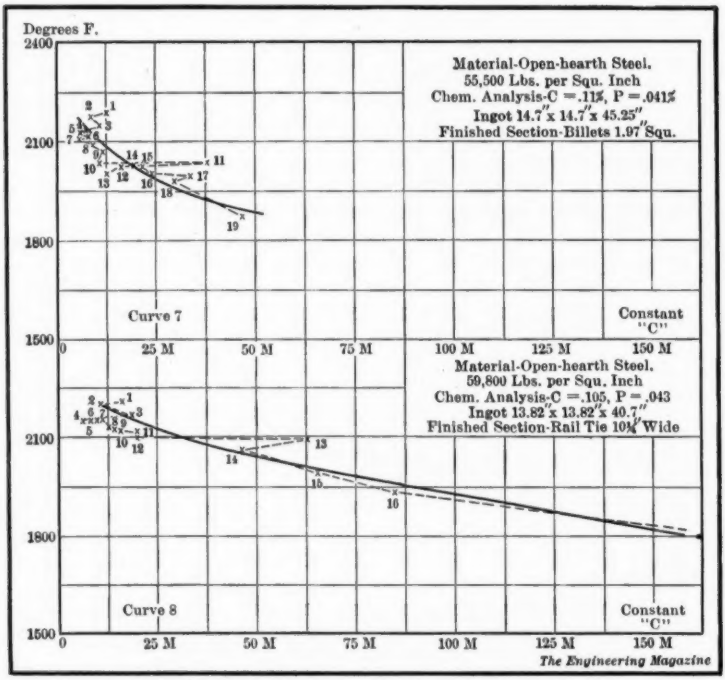


FIGURE 16. CONSTANTS C IN VARIOUS ROLLING-MILL TESTS.

The broken irregular curves are those obtained by connecting the Constants C as figured from the carefully conducted tests. This irregular curve I have chosen to call the "Roll-Characteristic," because with the same roll-passes, the same reductions, and the same temperatures, the same points must always be obtained in rolling a steel similar in character to the one rolled when the data for these points were procured originally. But this wavy, irregular curve seems ill suited to determine the power required for a rolling mill about to be designed. Among other things the purpose of the designer should be to do the necessary work of rolling in the different passes with the least expenditure of energy. If the work for the different passes be done most economically, the roll-characteristic will lose its irregularity and become a smooth curve the general direction of which is indicatd by the roll-characteristic. These smooth curves which are drawn into the points that form the roll-characteristic we will call

the Constant C curve for the section in question. If now the size of an engine or motor for rolling mill work is to be determined, it will be advisable to choose that Constant C curve which shows the smallest ordinates for the given abscissæ. For accurate results the proper Constant C Curve must of course always be chosen, i. e., a Constant C curve for plate-rolling would give only approximate results if used in computations for the proper size of a rail-mill engine or motor.

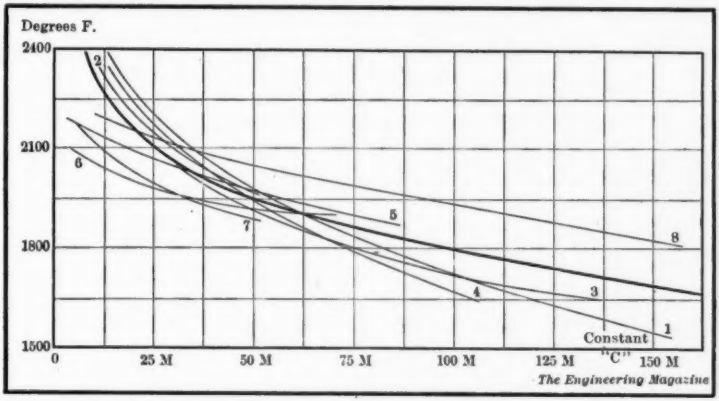


FIGURE 17. COMPARISON OF CURVES IN FIGURES 14, 15 AND 16.

In Figure 17 all the Constant C curves given in Figures 14, 15, and 16 are shown. A general averaging curve, A, has been drawn into these Constant C curves, which general averaging curve will be of advantage in the determination of the power requirement where many different shapes are rolled in one mill.

INFLUENCE OF MATERIAL AND SIZE OF ROLLS ON POWER REQUIREMENT.

The opinion is frequently entertained, and I confess that at one time I also held this opinion, that it takes much more power to roll the hard steels than is required for the rolling of the softer steels. Experiments made by careful investigators have proved, however, that this is not the case. The apparently larger power requirement of the hard steels, especially the high-carbon steels, is due to the fact that they cannot be worked at temperatures as high as those at which the so-called soft steels can be worked. The experimental data above referred to indicate that if the temperatures were alike for both soft and hard steels, Constant C for these two kinds of steel should also be alike.

It is frequently stated without qualifications that rolls of small diameter require less power per certain reduction than those of large diameters. This might be interpreted to mean that for a certain reduction of a given material at a fixed temperature the Constant C for a rolling mill with small roll diameter would be less than the Constant C for a rolling mill with large roll diameter.

It is perfectly evident why a rolling mill with rolls of small diameter will require less power than a similar mill having rolls of larger diameter, provided reduction, temperature, quality of steel, and revolution per certain time are the same in both cases. Under such conditions the mill with the smaller roll diameter is doing actually less work and therefore it should not require the same power as the mill with the larger rolls. As an example let us assume the following case:

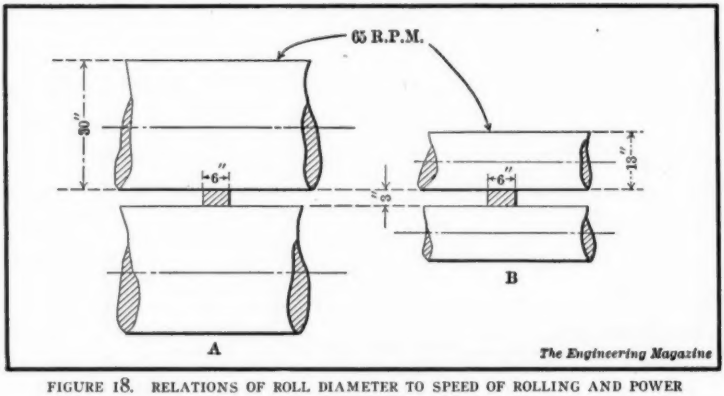


FIGURE 18. RELATIONS OF ROLL DIAMETER TO SPEED OF ROLLING AND POWER REQUIRED.

We have a pair of 30-inch rolls and a pair of 13-inch rolls, each pair revolving at 65 revolutions per minue, set exactly the same distance apart; and into each of these rolls is entered say a 3-inch by 6-inch billet, both billets cut from the same ingot and both heated to the same temperature; see Figure 18. Now, since the temperatures of the billets between both sets of rolls are alike, and further, since the rolls are set the same distance apart, and since the billets have the same dimensions, the reductions in both cases must be the same. From this fact that the reductions are the same it follows that the force or pressure exerted upon the billets must be alike in both cases. Let us assume for our numerical example that the rolls press upon the steel with a force of 100,000 pounds at the time of rolling.

The roll speed of the 30-inch rolls will be 8½ feet per second and that of the 13-inch rolls at the same number of revolutions per minute, 3.7 feet per second. In rolling, therefore, during one revolution the 30-inch rolls will convey the piece between them 8½ feet per second approximately, if we disregard slip and the forward stretching effect, and the 13-inch rolls will convey it 3.7 feet per second. In order to bring about the same reductions in cases A and B in Figure 18, the pressure in the case of both sets of rolls must be the same as stated already. This pressure was taken at 100,000 pounds during the rolling of the steel. The total work done on the billets will therefore be in the 30-inch rolls 100,000 × 8.5 or 850,000 foot pounds or 1,544 horse power and for the 13-inch rolls 100,000 × 3.7 or 673 horse power. If we now increased the revolutions per minute of the small rolls to 150, the surface speed will be the same as that of the 30-inch rolls at 65 revolutions per minute; the speed at which the billet leaves the 13-inch rolls driven at 150 revolutions per minute, will be the same as the speed coming from the 30-inch rolls driven at 65 revolutions per minute, and therefore since force, distance, and time are equal in both cases, the power required will likewise be the same in both cases. The real reason therefore why under similar conditions small rolls require less power in rolling than large rolls, is that the small rolls take more time than the large rolls for the performance of the same work if the revolutions per minute are the same in both cases.

The above discussion has been somewhat theoretical. In actual practice when the rolling of a billet or bloom during the entire mill-cycle is considered, if the necks of the two sets of rolls are the same, the small rolls at 150 revolutions per minute would actually require more power instead of less. This is so because in order to roll over a certain length the smaller set of rolls has to make 2.3 as many revolutions as are made by the larger set of rolls, and therefore the friction load is greater, not of course in proportion to the surface speed of the rolls, but still it is greater, and to this extent the friction load and therefore the total power required for rolling the steel in the small diameter rolls is greater instead of less.

We have also spoken of the great influence which the roll-pass friction has on the power requirement in rolling steel. The smaller the rolls the less will be the lateral widening effect of the steel, and therefore the smaller the roll-pass friction and consequently the smaller the power requirement. That the widening effect will be less with small rolls than with large ones is seen by the simple performance of stretching a piece of heated steel with hammers that have the

cross-peens all of one length but of different widths. A simple experiment of this kind will quickly show that the ratio of stretching to widening out is much greater with the narrow cross-peens than with the wider ones.

In order to design rolls intelligently we should have accurate data of the magnitude of the effect produced by lateral roll-pass friction, and this would make a very useful field of investigation for the experimental departments of our large steel companies. To know merely "of an effect" is of practically no value in work of this kind; it is the "how much" that counts. An experimental roll-train with a corps of efficient investigators carrying on experiments along broad lines would soon put roll-design on a scientific basis and take away from the roll-shop that much prevailing and foolish secrecy and mysticism.

Cost of Power in Rolling Mills.

In many iron and steel works it is necessary to determine for the accounting departments the power consumed by the different rolling mills in rolling the various shapes. In some cases accounting departments make estimates using engine or boiler capacities as a basis, while in others the number of operating hours is used as a basis for power distribution. Both methods are of course unsatisfactory and fundamentally wrong. The distribution of power should be based on the power actually consumed and on the tonnage produced in the mills. The power actually consumed in rolling mills depends upon the reductions, and not upon the engine or boiler capacities or the operating hours. If reductions are not considered the results obtained may in many cases be obviously far from the true results. Even if weight of steel and reductions are considered, the results will not be strictly exact because the temperature of rolling usually cannot be considered. However, even if temperatures are not taken into consideration, the average results for the given shapes will be sufficiently accurate if weight of steel and reductions are taken into account, since with a great number of billets or ingots under consideration the average temperatures of the steel in rolling will fairly well agree.

A very convenient way therefore to fix the power required for rolling the different products is to plot a chart similar to the one shown in Figure 19, in which the work for a ton of steel enters as a factor in the abscissæ and in which the horse-power hours are plotted as ordinates. The ordinates for this chart, which has been worked up from the data contained in Table 2 are determined as follows:

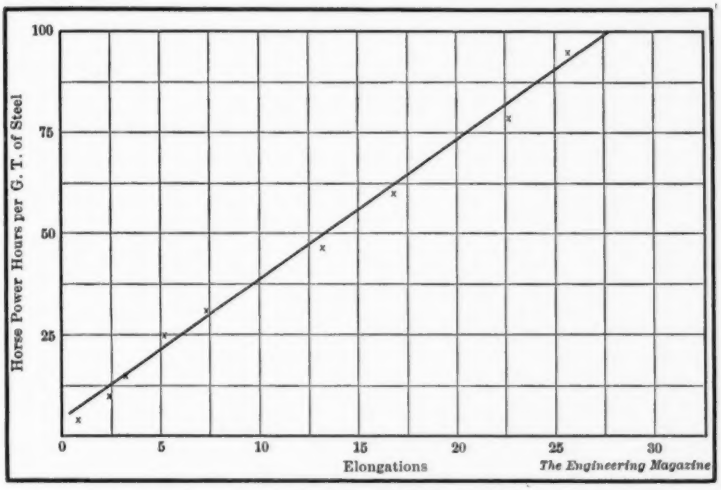


FIGURE 19. CHART OF POWER REQUIRED PER TON OF STEEL.

Assume an hourly production of 6.25 gross tons of finished plate. The trimmings on the shear table which are counted as scrap pass likewise through the rolls and they too must be counted. Assume this scrap to be 10 per cent of the tonnage made, so that the total hourly production is 6.87 gross tons. Before reaching the shear table each finished plate weighs 255 pounds; there must be rolled therefore per hour (2,240 ÷ 255) by 6.87, or about sixty billets. The average time of rolling each billet is one minute three seconds, and at this rate the total time of rolling the above tonnage would be 63 by 60 or 3,780 seconds or 1.05 hours. When the eighth pass of billet A enters the rolls, billet B enters the first pass; in this manner two billets are in the rolls for 22 per cent of the time during normal operation and for this reason the regular tonnage of 6.87 gross ton is usually made in 56 minutes actual rolling time. On an average, therefore, 4 minutes are used up every hour for unavoidable delays with tables, transfers, shears, etc. Since these delays do not come together but are scattered over the whole hour, the engine is not shut down but continues to operate during these delays. Therefore the total power chargeable to the rolling of one ton of steel must also include the power expended during unavoidable delays, and these unavoidable delays must find expression in the curve. A good way and one perfectly correct will be to charge this power expended during delays equally to all passes.

The friction load of the engine and mill is 188.87 horse power, which for four minutes would be 25,000,000 foot-pounds. Since there are sixty billets rolled per hour, and further since every billet receives nine passes, each pass would have to receive a delay charge of 25,000,000 ÷ (60 by 9) or 46,300 foot-pounds. The work chargeable to every pass will be the actual total work required for rolling that pass, inclusive of friction load from the beginning of one pass to the beginning of the next, plus the power chargeable to delays. This sum multiplied by the number of billets in one ton will give for the mill and the product in question the horse-power hours required for the rolling of one ton of steel in that particular pass; in the present case the horse-power hours are shown in the ordinates of the curve in Figure 19.

The above information, however, is expressed in terms too narrow for general application in the correct determination of the power charges in rolling-mill work. The actual effect produced should also enter as a factor into the above figures. This can be done by stating the reduction brought about in the pass in question in terms of the cross-sectional area of the finished rolling-mill product, or what is the same and perhaps a little more convenient, by stating the length of the steel after a pass in terms of its original billet or ingot length.

A set of curves for the different products rolled in the different mills giving the horse-power hours for the different elongations should be in possession of every steel-works accounting office which finds it necessary to show the power costs on the cost-sheets. Table 6 on page 233 shows some of the steps necessary in order to arrive at the values of horse-power hours for the different elongations of the steel.

Accuracies Obtained on Steam-Driven Mills and Electrically Driven Mills Compared.

It is often stated that in the case of electrically driven mills the power requirement for the different passes can be determined with greater ease and accuracy than in the case of steam-driven mills. This may perhaps be true in a measure; the electrical instruments are more convenient and perhaps are more accurate than the instruments usually employed in steam-engine tests. However, I desire to make the statement here that for practical purposes the horse-power computations carried to the second and third decimals, easily possible with electrically instruments, are of no greater interest than when they are carried to one decimal point only, which of course can be

done with the indicator without any trouble, provided all data including the speed of the engine are known for the time when the diagram was taken.

TABLE 6.

SHOWING HORSE-POWER HOUR REQUIREMENT PER GROSS TON OF PLATE (TABLE 2) FOR DIFFERENT ELONGATIONS IN A MILL WITH A NORMAL PRODUCTION OF 165 GROSS TONS PER 24 HOURS.

		Work Done on One Billet.			
No. of Pass.	Elongations in Original Billet Lengths.	From One Pass to Next One Inc. Delay Charge Ft. Lbs.	Up to Present Pass Inc. Friction Load & Delay Charge in Ft. Lbs.	Work Done Per G. T. of Billets. Ft. Lbs.	H.-P. Hours.
1	2	3	4	5	6
1	1.41	1,102,740	1,102,740	9,645,000	4.86
2	2.30	956,947	2,059,687	18,000,000	9.09
3	3.26	1,435,858	3,495,545	30,600,000	15.42
4	5.10	1,444,507	4,940,052	49,450,000	24.90
5	7.20	1,998,967	6,939,019	60,600,000	30.61
6	13.20	3,636,248	10,575,267	92,500,000	46.65
7	16.80	2,922,479	13,597,746	118,800,000	60.00
8	22.60	4,074,925	17,672,671	154,500,000	78.00
9	25.60	3,628,386	21,301,057	186,300,000	94.00

A further proof that it serves no purpose to carry the decimals beyond one point in the power computations of a rolling mill, I believe, is found in the fact that sometimes during rolling the pressure between the rolls is so great that the temperature of the steel is increased. I know of a test conducted with the greatest precision where by actual measurements an increase of 56 degrees F. was noted at the end of the third pass. This test was made on a three-high mill driven by a motor; in this mill a billet of 825 pounds was rolled into mine rails weighing 17.9 pounds per yard. The duration of this third pass was 1.11 seconds and the temperature of the steel just before the third pass as measured with a Holburn-Kurlbaum Optical Pyrometer was 2,095 degrees F. If according to Wedding we take the specific heat of a low-carbon steel at this temperature at .3, a rise of 56 degrees F. would in this case correspond to a power equivalent of

$$\frac{.3 \times 815 \times 56 \times 778}{550 \times 1.11} \text{ or } 17{,}500 \text{ horse power.}$$

Of course it is needless to say, the temperature of the total weight of steel was not raised 56 degrees F. but only a thin envelope of it. I know of no way by which to determine the actual weight of steel

the temperature of which has been raised during rolling. If, however, we assume that the temperature of a thin envelope of the steel spread over the entire billet and weighing just one pound was raised 56 degrees F. during the pass, we would still have a power equivalent of

$$\frac{.3 \times 1 \times 56 \times 778}{550 \times 1.11} \text{ or } 21.4 \text{ horse power.}$$

From this it is readily seen that for the work in question any electrical instruments enabling us to compute the power requirement closer than the steam-engine indicator will permit are of no superiority as far as practical accuracy goes, because it serves no purpose to eliminate a small possible discrepancy when errors more than ten times as great may occur which cannot be determined.

Increases in temperature during rolling are not as infrequent as many may suspect. In a list of over fifty tests which I examined carefully I found thirty-nine cases in which the temperature was higher anywhere from 2 degrees F. to 56 degrees F. in subsequent passes than in preceding ones.

Conclusion.

The employment of electric motors for rolling-mill drives makes it possible at any time to know how the rolling is conducted. The ammeter tells instantly the current used during any pass and the integrating watt-meter tells accurately the power used per ton of finished material. All this is most excellent information and it is the kind of information needed by the electrician, roller foreman, superintendent, or manager of the works. But the designer needs all this information and a great deal more besides. For him the chart of a recording ammeter or watt-meter is not sufficient; he must know in addition and with equal accuracy temperature at rolling, reduction, time of different events, speeds, etc., and of course concerning these electrical instruments cannot give any information.

The great difficulty experienced in arriving at the proper size of engine or motor for a rolling mill is due to the fact that not all the necessary information is at hand when the dimensions are worked out, and consequently all computations and estimates are based on what some other mill is doing. It must indeed be considered remarkable if under such conditions the new mill fulfils all previous requirements. There are perhaps no two cases alike, even if the same tonnage is to

be produced by each mill. If it were stated for example that it takes say 95 kilowatt-hours per ton to roll plates of 51-inch by .22-inch sectional dimensions from a billet weighing 450 pounds, it does not at all follow that in some other mill it will likewise take 95 kilowatt-hours per ton produced. In another mill the temperature of rolling, the speed of the mill, and the number of passes may be different; the reductions may be distributed differently—in fact, the entire roll-pass design may be different. All these items have an important influence on the power required in rolling.

As power for a rolling mill one of the following may be chosen: steam engines, gas engines, direct-current motors, and alternating-current motors. The characteristics of these types of machines are not alike, however, and as a matter of course these characteristics must be considered so that it may be determined in advance what effect the different load conditions will have on the engine or motor.

The steady and economical operation of the mill depends in part on the absence of roll breakage. To avoid the breaking of otherwise good rolls it should be known in advance just what the allowable reduction is for a set of rolls and what stresses are set up by the different reductions. With regard to these matters only reliable and detailed tests of course can furnish information.

In the design of a new mill it is highly desirable that the engine, or whatever other motive power is used, work at a load as constant as is possible in rolling-mill work. In order to accomplish this constant operation it becomes necessary to design the different passes as nearly alike as is obtainable from the standpoint of power requirement. The equalizing of the power required for the different passes is accomplished by a proper proportioning of the roll-speed and by a proper proportioning of the reduction. In a two-high mill this proper proportion is accomplished by taking the first passes slowly with a considerable draft. The finishing passes are taken with much less draft and with much greater speed. In this way the power required for the different passes is equalized. The same thing is accomplished in three-high mills by running the finishing rolls at a greater rate of speed than the roughing rolls.

In this discussion we cannot of course attempt to point out all the different uses of the data contained herein. But the intelligent, rolling-mill designer and rolling-mill man will have no difficulty in making proper use of these data as problems arise in their work which make exact information necessary.

THE ORGANIZATION OF GREAT CORPORATIONS.

By Wm. W. Mulford.

IF you are a corporation wage earner, and seven out of every ten of the wage earners of the United States are, then you surely have a fellow feeling for the office boy who, as the story goes, when asked "Who is the responsible party here?" replied "I don't know who's responsible, but I'm always to blame."

Was the boy at fault, or was the root of the trouble deeper, possibly in the organization itself?

The "Trusts" are with us because they fill a specific requirement. They are well worth while and when their virtues outweigh their faults are greatly to be desired. How firmly they are entrenched may be judged from the statistics which Mr. Winchell, president of the St. Louis and San Francisco Railroad, has given us:

> There are more than one million corporations doing business in these United States; of all the capital employed, 82 per cent is in the carrying on of the business of incorporated concerns; corporations employ 71 per cent of all wage earners, pay 72 per cent of all the wages, and buy 75 per cent of all the materials used in manufacturing enterprises of the country.

For the industrial world these figures challenge attention.

It was my honor to know Dr. Orton, a "Louis Agassiz man," one time president of the Ohio State University. In discussing the economic conditions of the day, about the time the first steel corporation combinations were being formed, I asked, "Dr. Orton, what do these combinations of big corporations lead to?" To which he replied, "I am very optimistic on the outlook. They lead to socialism." "But, Dr. Orton, you are not a socialist, and I am not a socialist!" And as I recall it, this was his reply:

> Well, I am an old man, I can prophesy. You are a young man. It will not do for a young man to prophesy. We are neither of us socialists in the sense of the fanatic so-called German student, nor in the sense of the labor-union demagogue, but there is a right form of socialism. You have seen the oil business gradually absorbed under the control of one great corporation, or call it "trust" if you like. You have seen the same thing in the sugar business. And now the iron men are attempting to

work out their industrial problems. You will see a great corporation formed, call it "Steel Trust" if you like. This will be dominated by one strong man, possibly an unpopular man, possibly a selfish man, possibly a narrow man, certainly a far-seeing man of strong will and determination. But he will die. Another man with perhaps a little broader humanity and not so strong will power, will take his place. But he, too, will die. The time will come when the great rank and file of men engaged in this industry, the men with money, the men of brains, and the men of sinew, will realize that they are themselves the foundation strength of the steel business. The industry will have developed from the "one-man" policy to the broader and stronger policy determined by the will of the majority of the true masters of this particular industry.

I believe that you will live to see the time in this country when not only the Declaration of Independence, and the Constitution of the United States, but also the Recognition of Industrial Organizations are the prominent forces in the land.

The outlook following the financial storm is brighter than it has been for many a long day. Even in the silver lining of the storm-clouds it is apparent that the right development of the corporation is a vital question for business prosperity, if that prosperity is to have any permanency. Now is the time to take another buckle in our belts, study the compass, set our course truer, and prepare for a longer, surer run. The prevailing idea seems to have been that the corporation officials, "captains and lieutenants of industry," were definitely divided into two classes; first, the builders up, creative men, orderly men, planners, and executors of great undertakings, of great enterprises, of great organizations; second, the tearers down, those who by destroying one combination possibly establish another, those who profit by destruction, those who gather in the forced temporary profits from economies brought about by cutting down maintenance so as to show increased earnings and "getting out from under" before the investors are "wise." Experience teaches us there is a third class of equal importance, the confusionists, those who thoroughly tangle up affairs through a maze of multiple corporations, through a labyrinth of combinations of controlling interests. Any worker can choose which of these classes he prefers to join, but he may find it difficult to keep in that class, no matter how earnestly he strives. The game, though only in its infancy, is keenly interesting, the pace set is strenuous, "it is not so much where you are, as which way you are going that counts." This is equally true, for the individual, the labor union, and the corporation.

"Education is the only interest worthy the deep, controlling anxiety of the thoughtful man," so Wendell Phillips told us. Possibly in a broad sense a corporation is only the curriculum of the great live American business university of today.

A composite photograph of the forms of organization of the many corporations has its educational value, because the mastering of economic conditions through common business customs, whether it is pioneer work, development work, or the carrying on of an established enterprise, requires an organization of forces which is briefly the means of accomplishing and adjusting the division of labor. If it is desired to establish in any industry co-operative methods that save waste and increase profits and efficiency, it is necessary to acquire more than the first rough use of the power of organization.

The kinds of work are so many, are so diversified—there is such a wide difference between the ways of the easy-going chap and the ways of the martinet (though both frequently are eminently successful in their management of corporations and men) that at first it would hardly seem possible that the form of organization of the great corporation was already assuming uniform shape.

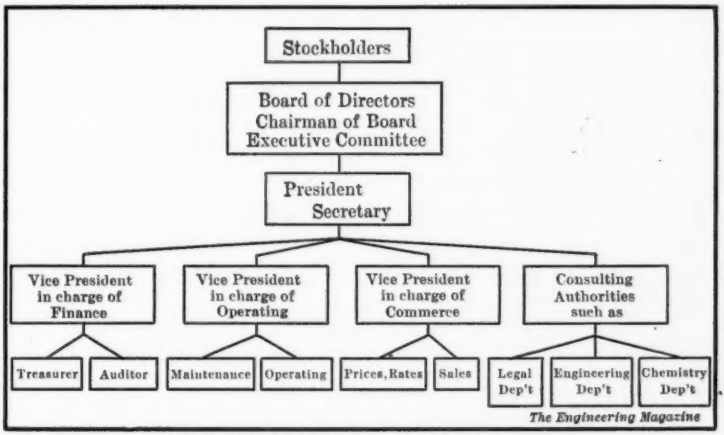
Like all wholesome American business methods it is a matter of evolution. The better forms have been adopted after careful studies of those already used in doing similar work. These are changed, modified, or revised to meet the conditions and requirements of the particular work; then improved and simplified in order to obtain greater efficiency and to yield larger results. Certain customs are common to many of the successful big corporations. This has gradually brought about a standardization of their forms of organization. Certain fundamental principles are so clearly recognized that they can well be considered as established. These are summed up and expressed in what is known as the "three-column form."

Broadly speaking, there are three distinct branches in the work of all large corporation organizations, Financial, Operating, Commercial; all other positions or departments are either subordinate to these, or are practically consulting authorities. This holds true whether in industrials or railroads, whether in the single corporation or in the series of corporations, and whether the departmental, the bureaucratic, the divisional, or the functional form of organization is used.

A chart of the usual "three-column form" of organization is shown on page 243.

The reason why the three-column form of organization holds true in so many apparently distinctly different kinds of organizations seems to rest upon the underlying principle of an old saying—"Even in a Democracy there must be a leader." This is equally true in carrying on a business. There is always a fixed policy to be car-

ried out, although that policy may be of the *laissez faire* variety. There must be a leader; and furthermore each department, or bureau, must have a head, and these are the lieutenants of the commander in chief. But organization is the antithesis of administration. Under the three-column form of organization the distinction between administration and organization is so clear that it is instinctively understood by every employee.



TYPICAL ORGANIZATION CHART FOLLOWING THE THREE-COLUMN FORM.

The reason why the financial, operating, and commercial divisions rather than any others are the chief is that the form of organization is not determined by the size of the department, the number of employees, or the volume of work, but by the relative importance of the work and its relationship to the policy of the company. The salient questions of finance, operation, and commerce affect directly the policy of the corporation, and are wholly dependent upon one another. First, the money must be provided. Second, the work must be done. Third, the product must be sold. The best salesman cannot sell unless he has the goods to sell. He knows what the market requires, and what prices he can obtain. He knows how to create selling methods. With that given, the skilled operating man knows how to manufacture what is demanded, or to perform the service that is required. With these two given, the financial man must not only provide for the money but must ascertain beforehand whether the monetary market warrants furnishing or withholding the supply, for financial emergencies must be prepared for well in advance. These are the vital features of any business

policy. In the three-column form, the vice-president in charge of finance, the vice-president in charge of operating, the vice-president in charge of commerce, are on an equality; they are peers, and have an associated authority and responsibility.

For this creature of legislation, the corporation, the board of directors is the sovereign power, subject only to the laws of the land. Following the chart, the chairman of the board is the highest official of the corporation. Frequently there is an executive committee of the board of directors. This, however, is usually only a division between the active and inactive directors; possibly it is more courteous to call them "less active directors." Again following the chart, the board of directors, or the executive committee of the board, selects the president who is chosen to carry out their policy. Therefore with a given policy, which he is pledged to follow, the president becomes the chief executive of the corporation. He appoints as his executive staff vice-presidents and consulting authorities, in accordance with what he deems to be the essential requirements of the business or work.

The three-column form of organization makes it possible to separate the work of direction and deliberation from the details of execution, and also makes the executives of the great vital departments parties to these deliberations in their positions of staff officials. In this rests its greatest strength.

By increasing the number of vice-presidential staff positions little or nothing is gained. For instance, it is necessary to have the treasurer's and auditor's departments absolutely separate, for the one is a check upon the other. If both the treasurer and auditor are members of the official staff, and unless they work in wonderful harmony, it means that many questions relative only to these two departments are brought before the staff, seriously increasing its routine work and hampering its work as a whole.

Where there are bureaus of information, these are each under the control of a chief, and may either be staff positions similar to the other consulting authorities, or may be, as is frequently the case, a branch of some specific sub-department.

By decreasing the number of vice-presidential positions the balance between finance, operating and commerce is destroyed. In certain classes of work, or in the early stages of development, any one of the three vital divisions may temporarily overshadow the other two; this, however, in no case alters their relative importance. The corporation may be so small that one official may hold and

direct much of the work personally, thereby combining several positions. The ability of the individual together with his capacity for work determines how far this can be successfully carried. For instance, one important railroad had a departmental organization where each department reports to the president. In this case the president practically holds the two positions of president and general manager. Another much more extensive railroad property, which uses the three-column form to its full extent, makes the division the unit, and places all the powers of a general manager in the man at the head of each division. In the series of corporations, the sub-corporation is sometimes the unit. The determination of what the unit may best be is found by carrying the adjustment of responsibility, authority, and the division of labor down through the organization.

What the unit may be has an important bearing on the method of training the men. The career of the young employee is of great moment to a corporation intending to continue its business for any length of time. While there is no patent on ignorance still there are may ignorant men. Men have to be trained and the training has to begin early and extend through many branches of the service in order that they may become competent and efficient. Even when the right material has been developed the best of men cannot produce results under a faulty or vague organization with its inevitable lack of exact responsibility.

The employee must not only know his duties and what is expected of him, but also rather than have obstacles placed in the way he should be able to obtain in a convenient manner, in so far as they affect his work, all the information, statistics, data, and even an understanding of the policy of the company, if he desires to seek them. Unless this is done, it is impossible to avoid duplication of work; or what may be more discouraging, the employee may suddenly find out that half of the work he has done has already been done by others and probably, because they had more time for it, in a more thorough way. Here is where system becomes manifest. Here is where true *esprit du corps* is nurtured or destroyed. Here is where man's originality is crushed, or he gains the joy of achievement. If he is to "play up, play up, and play the game," he must know the rules of that game.

For the individual competition is keen, he must make good every day, all days, month in and month out. If a man resigns, his place is at once filled for there can be no vacancies in a good organiza-

tion except at the bottom. The pace set is often terrific, heart-breaking, soul-racking, frequently leading only to nervous break-downs. When this occurs the organization is somewhere at fault.

Together with the striving for place, there is the ever increasing pressure for results. An editorial writer in an able article in a recent *Railroad Age Gazette,* speaking of the units of work in use in common railway work, points out how "reputations are made and blasted in terms of these units or 'results' while real causes and effects are lost sight of," but that is the unit of work not of organization and is "another story."

In a series of corporations, especially, the bureaus of information for specific subjects or the departments for particular branches of the business are of inestimable value. Frequently they cause trouble and confusion, showing that the organization is at fault. But under the three-column form of organization they naturally take their proper places, establishing their true relationship to the organization.

Extravagant ceremony and superabundance of "red tape" are often mistaken for system. It is the mistake of being too highly organized, and can defeat the very end for which the organization was created. It is quickly apparent when an organization is too rigid, and the three-column form is undoubtedly the most flexible and elastic of any so far devised. An old privileged workman when told that the new president of his company in a popular address defined "organization as the handmaiden of administration," said "I make no odds about the handmaiden's looks, nor about her merry widow hat, but did he say whether her dress was of red tape?"

When an organization is successful there is no false motion. "The man who does things" is usually the man who can so adjust his organization that he is securing the greatest efficiency, that each man is doing the work in which he is most proficient, and that no two are working at cross purposes or causing duplication of work. The form of organization is among the problems of today, and full success for the head of any organization depends largely upon his ability to choose able lieutenants.

If you turn to the "Official Guide of the Railways" which is the railroad man's handbook, you will find the form of organization and its personnel as shown in the official roster of each road. It is quite remarkable how closely they follow the three-column form of organization. This form, so successfully used by Mr. Cornelius Vanderbilt 2nd on the New York Central and Hudson River Railroad

and Mr. Cassatt on the Pennsylvania System, was so skillfully made use of by Mr. Harriman in his great combination of Railroad corporations that Judge Lovett's announcement of the official organization of the Union Pacific merely emphasizes its value. Mr. Julius Kruttschnitt, in a paper read before the New York Railroad Club, shows how thoroughly the organization of the operating division has been worked out, together with its relation to the traffic or commercial division. An interesting point in Mr. Kruttschnitt's paper is his comment regarding the meetings held by the various operating heads of the several properties. "They are legislative bodies assisted by the individual general managers as expert advisers and subject to the approval or veto of the director of maintenance and operation." In this is shown their educational feature or, to use his own expression, "a means of disseminating education to officials."

In the telephone organization only two of the three great divisions of the three-column form of organization are predominant factors, finance and operating. And because there are only two, the power swings like a pendulum from one to the other, for a few years the one dictates and then the other. The commercial division has not been given an equal standing with the other two. It is said that this is because business has always come to them as fast as it could be conveniently taken care of and that they have not had to seek a market except occasionally for a by-product. However that may be, it is true that if a balance in power is to be maintained between finance and operating, it can only be accomplished through the recognition of the commercial division as their peer.

Mr. George W. Perkins in his article "Humanizing A Corporation" in *Appleton's Magazine* wrote:

> The formation of the United States Steel Corporation meant that individual ownership of some of the most prominent steel industries of this country ceased. To men and students of affairs the real problem that faced the new corporation was this: Could men on salaries and wages successfully carry on this vast organization, directed only by other men on salaries—with no proprietorship above them save a vast and scattered body of security holders?

The far-reaching and efficient plan arranged by Mr. Perkins making it possible for those employees who so desired to become shareholders, and in that way partners, so to speak, with the corporation has proved highly successful. The results form a most important chapter in the educational work of organizations.

There are specific kinds of work which require rather remarkable organizations, for instance, that of a great mail-order house, or that of a great engineering undertaking such as the building of the Panama Canal, or that of the "Base Ball Trust" which is said to be the most effectively organized "trust" in this country. There are some forms of organization which show clearly the imprint of West Point training.

The importance of the form of organization is constantly increasing. Certain men of large affairs when considering granting a loan, or taking up an issue of bonds, investigate thoroughly the form of organization to know the relative authority and responsibility of the personnel; whether it is a one-man corporation where one individual dominates, or whether a group of broadly and thoroughly trained men are in charge. What authority have the lieutenants; are they automatons, or men of vigor and character? For the investor next in importance to the story told in the company's balance sheet is the story told in the form of organization.

There is a vast difference between running an organization (or a government) by the mass of employees, such as trade-unionism suggests, and running it through a well-perfected, well-balanced organization which recognizes the rights of the public, the rights of the investors, the rights of the employees. The public as represented in the prices charged for the service they receive, the commercial division; the investors in the dividend and interest returns on their money, the financial division; the employees, in rendering maximum efficiency and receiving credit for work well done, the operating division. Under the well-balanced organization there can be no privileged body of men who can dictate terms to the rest of creation. The true three-column form of organization is for the trust a safety guard against trouble from misguided labor agitation, from retaliatory legislation, from financial dilemma.

The rapid growth and far-reaching consequences of our industrials, our railways, our quasi-public corporations, show the importance of this problem. Involved in it are not only the questions of civil service, of labor and capital, but also of maintaining what Toynbee called "equal industrial opportunity." The individual is the atomic unit of the organization. In recognizing and respecting "the rights of the individual as a person" well balanced industrial organization becomes the corner stone of the science of sociology.

THE "OUTSIDER" AND THE BUSY BUSINESS-MAN.

By William Perry.

The value of the author's suggestions comes from his presence in places where "outside" specialists have been called in to make improvements, and upon his subsequent connection with a leading firm of outsiders. This combined experience puts him in position to judge without prejudice both sides of the question, and to speak with some authority as to the selection of outside talent.—THE EDITORS.

ONLY a few years ago, executives began to consider the *possibility* of accepting aid from the "outsider" in manufacturing, administrative, and selling difficulties—the trained outsider whose business is to come in and find means to obtain increased profits or money-making economies.

Since then the question has lost much of its importance, for the business man has seen repeated evidences of "outside" capabilities; he has learned that not one in twenty improvements of machines and methods comes from the "inside."

Today he is face-to-face with a different problem; and the problem is, which outsider to choose.

For the most part, this should depend upon relative experience, and upon what needs to be done in the way of simplifications, improvements, and expansions. As an example, if you are *sure* that nothing more serious than your book-keeping forms need revision, you should call in a systematizer—taking the precaution to select a man whose oldest as well as newest clients speak well of him. Above all, make sure that the systematizer has no interest in the sale of material or supplies which he recommends. When he recommends six forms, question him as to why three are not enough. If he says you need a dozen files, ask him why you cannot do with less. You can generally tell by his replies whether the quantity-recommendations mean anything to him. Failure to be assured of this point risks your being loaded with myriad places for hiding information that ought to be instantly available. Considered according to his limitations, the systematizer is all right; but beyond those limitations he is apt to be no better "guesser" than you yourself.

Perhaps it happens that you are aware of the incapacity of some piece of machinery. In that case you are right in engaging a prac-

tical designer to rebuild or develop it. Again, you may know exactly what sales policies to pursue, and what territory to cultivate. Perhaps all you need is a skilled "copy-writer." So long as you are *sure* you know exactly which specific things need correction or improvement, it is not difficult to find the right outsider.

What troubles the business executive is to learn *just which particular conditions will repay investigation and improvement;* just what things will do most (for a given sum invested) toward distancing competition—just what will aid the factory whose delivery promises are notable for their "brittleness."

If you happen to be a man who does not realize how widespread the search has become for the *right sort* of outsiders, you have only to interview five or ten big men in the business world. Some of them will tell you that their firms engage individuals who devote their entire time to effecting improvements in one department after another. Others (wiser ones) will tell you of an arrangement by which they have the pick of the experts composing a firm of "business surgeons" for as many days' service as may be required, paying each month for whatever service has been rendered the month previous, and thus being assured a minimum fee.

A little investigation of this sort will prove to you beyond any doubt that emphatically the outsider is here to stay—and that under the present degree of competition among the different firms of outsiders, each will "stay" only as long as it can make good with clients —not a month longer. Each year's crop of professional outsiders (whether culled from the membership of other similar firms or from the union of individual business-doctors) *remains in business less than one year,* on an average.

Like every other form of professional service, the basis upon which the outsider is successful is merely the basis of giving a liberal return to the client. on the sum invested. There is no other basis that can hope to be permanent. Everyone knows that the value of experience is cumulative, and therefore each additional year of business life multiplies the service-value of an outside firm.

Speaking from a number of years' experience in seeing outsiders employed by firms with which I was connected, and following this with almost five years active work with one of the best known of these outsiders, some few points may be of value to the business man who finds it difficult (or something worse) to maintain profits in the face of growing competition; who sees his manufacturing profit or

his selling profit drop off, while rival firms appear to be making money. Whatever value these suggestions may have is enhanced by reason of experience with both sides of the question.

The most important thing to do when selecting an outsider is to *try him out*. Let him demonstrate what he can do and leave you to be the judge of whether the accomplishments represent good value for the fee named. You cannot afford to overreach him in such a matter, for if his service is really valuable, you want the benefit of *all* he can do for you. On the other hand, he cannot get the better of you; for you see what you are buying. After such a demonstration you are prepared to take him on at his regular fee, if he has made good.

Don't handicap him by restricting his work to one department, unless he himself suggests it. Usually the proportion of interdepartmental problems is at least three-fourths of all the problems met with in business. Each method, or process, or handling seems to have an effect upon other methods or processes or handlings almost beyond belief.

Let him go through your place, observing everything—but keeping his observations to himself, for fear of disrupting discipline by half-baked conclusions. Let him make note of improvements wherever he can find them. If he picks out "easy ones," judge him accordingly. If he digs deep, and gives you liberal value for his fee, don't let him go until he has done his utmost for you.

From the very outset, get out of your mind the notion that being in any business for many years teaches one all there is to know about that business. Generally, one is more likely to wear a rut so deep that one cannot see on all sides.

Perhaps you have wondered why these outsiders (if they really *are* such clever fellows) do not make permanent connection with some firm. They would not be satisfied to stay in one place very long. I know a positive genius in the mechanical field who deliberately threw up his contract with the outsiders and set about looking for something new, just because his firm wished him to remain indefinitely on a contract. He said he was sick and tired of the plant, and the city, and the faces he saw every day. He wanted something new. He wanted to analyze new problems, and he wanted to see other lines of business.

It is because of his resemblance to an inventor that the outsider prefers to go from place to place. He enjoys difficult administrative

or industrial problems just as an Egyptologist finds pleasure in deciphering fragmentary inscriptions of ancient times.

Experience has proven repeatedly that the outsider does his best work when he changes about. Sometimes he finds a method of handling or inspection in a shoe factory which suggests to him a means of speeding up production or economizing space in some entirely different line of business. (Not long ago, an outsider found that by slightly adapting an addressing machine, he had a rapid and accurate means of attaching textile samples to color cards.)

Keep the outsider with you just as long as he is able to find profitable things to do. Keep him away from your competitors until you are certain of getting the maximum benefit from his inventiveness and experience. Very likely, after his first accomplishments, you may get better results by making the service intermittent; a week or so at a time.

Selecting the outside firm means giving preference to one whose members specialize on certain things. This gives you a distinct advantage, for when you have a machine-designer, or floor-and-wall-space specialist, with you and he sees an opportunity for more efficient handling of shipments or orders, he will give his ideas to another member of his firm, whose specialty it is—and thus instead of the amateur skill of the man who goes beyond his specialty, you will have the professional work of the expert. So, if you have a man with you who is analyzing your sales, or salesmen's efficiencies, or development of territory, he may think of a better way to wrap or pack your goods. If such a man is wise he will have his judgment affirmed by some of his associates, who will advise him concerning practicability and comparative expense of the new method.

Some suggestions which come from non-technical men are very profitable, but only after they are worked out. Knowing little or nothing of the technique, an expert may sometimes think out a plan along lines supposed before to be impossible. For example, printer's ink has been packed for years in a certain way. A firm of outsiders had two or three of its men with a prominent publishing house. They found a large amount of ink being lost because of irregular and left-overnight runs. They didn't see any other way of packing the ink. But another member of the firm (a selling-and-distribution man) suggested a radical change in the ink-container. Not knowing much of mechanics, he was not able to work it out; so back went the suggestion to the technical men, with the result that they found in the

open market all the material needed to give the client advantage of the suggestion. As a result thousands of dollars worth of ink were saved. No individual outsider, working alone, would have accomplished the improvement.

When the outsider is a "narrow" man, who seeks to do it all himself without calling in assistance, the client is invariably the loser.

If you happen to have several stores, or factories, or offices, you will do well to put it up to the outsider to say which one he will take up for demonstration. If he is thoroughly alive to his opportunities, he will choose the best-managed one, because if he can be of service there he is sure to be of even greater service in the case of the others. If he does *not* choose the best one, it is pretty good evidence that he is looking for something easy—and that in turn suggests lack of confidence in himself.

Having decided which firm you will choose, and proved its abilities through demonstration (both as to analysis of existing conditions and creative ability in improving them), the next step is to prepare your working forces and sub-executives for their coming. Do not do as one eastern man did, on an occasion where I was called on to locate sales troubles and build up sales profits. After telling his salesmen to wait beyond their usual leaving time, he brought the outsider before them with an introduction like this: "This is Mr. So-and-so. He is coming in to find out why you salesmen don't sell more goods. Look out, or he'll get your scalps!"

Imagine that as an introduction to men who had kept locked up in their heads information that their house needed. The outsider knew that the head of the house intended to be humorous, but a single glance at the faces of the men told him they didn't appreciate the humor. It meant plain bread-and-butter to them.

Do not make that sort of mistake when you introduce the outsider. Tell your people instead that he comes to co-operate with the house and the working-forces; not with *one,* but with *both.* Tell them the outsider will do *some* things that have been in mind for quite a while, and other things that result from the analysis of conditions to be made. Ask them to help him in every way; and explain that by doing so they will be helping themselves through helping you. Say that the outsider has requested permission to talk to them one by one, so as to get their ideas, as well as the ideas of the firm. This will go a long way toward facilitating the work; for it is always pleasant (and only human) to learn that one's opinion is sought for.

Such an introduction will not only make the outsider's task pleasanter, but he can thus perform his work more quickly—and that means shortening the service-fee you pay him.

Some executives think it unnecessary that the outsider should get the working-forces' point of view. They are wrong; it is essentially necessary, if work of permanent value is to be done. You would not think of going to your lawyer and telling him only half the truth, nor to your doctor. They could not do their best for you on half-truths. Neither can the outsider.

Of course your people will "knock the house." Expect it. What do you care? Some of the "knocks" will be founded upon prejudice, no doubt; others on envy. But out of the lot will come a few that are honest criticisms of existing faults you do not know about—or knowing, do not realize the seriousness or costliness of not attending to them. They may concern the management of the firm or its products, or its treatment of customers or employees. Those "knocks" which it is most necessary you should know are apt to be kept from you by your people; for fear of losing their jobs, or else perhaps for fear their criticism will be taken as *lese majesté*.

Usually, like individuals, business enterprises profit by "knocks" just as surely as by "boosts." So be prepared for them; expect some of them to hit you hard, for your own good. Leave it to the outsider to judge which is which until he makes his report or recommendations.

There is another thing. Do not expect that every recommendation of the outsider will be a stroke of genius. If he is sincere and thorough in his work, he is likely to suggest small improvements as well as large ones. Measure his work not by the poorest recommendation, but by the total value of the good ones.

Suppose a quarter of his suggestions contain nothing of marked value. What difference does it make, if the remainder are worth enough to make the service-fee well invested? Suppose a full half of his suggestions are of limited worth. That merely shows he has done all in his power to make good with you. If he was looking for a personal record for brilliancy, he might ignore all except the spectacular improvements. But you know how few spectacular things occur in the steady grind of business. Take outside recommendations on the same basis. If he is the right sort of outsider, he will give you the benefit of everything which he believes will help you. Often it happens that an idea which is offered almost apologetically

contains the germ of a radical, or even revolutionary, improvement; and when the outsider is one who is inclined to "play to the gallery" he may withhold the incomplete suggestion for fear of marring his personal record.

There are "sacrifice hits" in methodizing as well as in baseball, and sometimes they are quite as productive of good "to the team."

So encourage the outsider to suggest *all* the ideas and improvements that seem good to him. Some may need development that can be made only by a man with the technique of the business at his command. Yet the man who possesses *nothing but technical knowledge* of the line would scarcely think of recommendations outside the customs and practices of that line.

Consider carefully and separately every recommendation—first on its own merits, and then in *combination with the other recommendations.* Talk each one over with the outsider, and get his point of view. Find out how he expects the recommendation to be valuable to your business. Then be content if three, or two, or even one out of every five recommendations proves both profitable and important. Do not think of the others as surplusage: think of them instead as good measure—bonus—utmost willingness on the outsider's part to serve you well. The most capable outsider will now and then make unimportant or doubtful suggestions. Reckon his value not in them, but in the remainder.

And just one more suggestion. When you get the outsider's recommendations, do not skim them over. Go into each one carefully. Perhaps a suggested plan or method may not appeal to you at first; but don't turn it down out of hand. Remember it is being presented together with a number of others, and you must judge of the whole result, rather than the prospective value of any single recommendation. The outsider is risking his professional reputation in what he recommends to you. In return, you owe him the benefit of the doubt as to feasibility of any suggestion that is to be used in connection with various other suggestions, for the good of the business as a whole.

Make up your mind which recommendations you can have your own people carry out; leave the rest to the outsider. The especial advantage of having the outsider install his own improvements is that he may have opportunity to utilize the *improvements on the improvements* which suggest themselves to him during installation. Trust to his personal pride to do his best to give you the benefit of these re-improvements; for he knows that his future reputation rests entirely upon the efficiency of past work. The same pride will pre-

vent his installing anything that will not operate practically, even though he may have made the error of recommending it in a report.

Make up your mind that the outsider is here to stay. You cannot afford to overlook the benefits he can obtain for you, any more than you can afford to ignore telephones, or typewriters, or modern automatic machinery.

Select your outsider with care. Look up his references. Don't bother to ask *what* he did for them. They may not want to tell you; and even if they did, that would be no proof of his ability to serve *you* with equal profit. Ask the references just one question. "Was So-and-so's service a good investment for you?" That's all. Then when you have good words from several *diverse* lines of business (thus testing his creative ability) try out your man. If you find him painstaking and inventive and clever, *work with him;* stimulate him to do his best; put him on his mettle; let him do his utmost for you before you release him to your competitors.

In short, if you would get his best thought, make an associate of him—not an employee.

EDITORIAL COMMENT

Co-operation, Competition, Efficiency.

JUDGE GARY'S defense and advocacy of co-operation as an industrial policy, contained in his address as first President of the American Iron & Steel Institute, has been widely discussed. To most commentators the most important suggestion seems to be that (emphasized by the conditions under which the address was delivered) of closer international accord between steel manufacturers of the world. The significance generally discerned or noted is limited to the external relations of the steel trade —its attitude toward and power over the consumer. Considering its circumstances, however, the United States Steel Corporation has been probably as benevolent a despot as any created by the passing era of gigantic consolidations; and if the present management or its spirit remain in control it is not likely the policy would be materially changed or the treatment of the steel-using public would become materially different, even if the closest co-operation were established between British and American steel producers.

The question which seems to have missed the notice it deserves is what will be the internal result of long continuance of the policy of co-operation? Can the steel industry, under conditions approximating ever closer to monopoly, retain its energy of evolution—will it remain as it was in the past an industry of incessant achievement, of progress in methods and equipment, progress in technology, multiplication of output through improvements in practice; or will it become an inert Colossus—gigantic, but stationary? To revert to Dr. Orton's opinion quoted by Mr. Mulford elsewhere in this issue, *can* "the majority of masters" in an industry achieve the results that the autocrat achieved? Can organization, however able and conscientious, carry forward industrial progress on the curve traced by individualism during the past half-century?

It is too soon yet to tell, for the impulse given by individualism and competition is still active. The first advantages accruing through the saving of the wastes caused by competition also complicate measurement of the total result. But if history is a guide, consolidation, monopoly, organization to carry on this monopoly, standardization of methods as a corollary of organization—all lead eventually to loss of momentum, stagnation, ossification.

The new philosophy, however, that may change the whole trend and termination of industry under its newer influences is efficiency. Under this energizing stimulus, without the warfare and waste accompanying competition, a like progress may be attained, as Harrington Emerson has pointed out, "not by individual striving, but solely by establishing, from all the accumulated and available wisdom of the world, staff-knowledge standards for each act—by carrying staff standards into effect through directing line organization; through rewards for individual excellence, persuading the individual to accept staff standards, to accept line direction and control, and under this double guidance to do his own uttermost best."

Engineering by Commission.

FAILURE to secure bids for private construction of the proposed New York subways is the outcome of conditions that have come into existence very swiftly, and with rapidly rising influence will affect the future of material development.

Exasperated at being exploited by individuals or individualized corporations,

the people have asserted their yet inchoate power to control the "interests;" and the interests, uncertain how long the storm will last or in what direction it will blow, are sullenly guarding the structures reared on old foundations, and refusing new ventures. As the country is not yet ready for wholesale municipal or state socialism—the construction by the community of its own industrial, power, or transportation projects—there is marked stagnation. It is not an episode, but a preliminary experience in a new order of things. For the present, however, it has the curious and unfortunate effect of indirectly strengthening the position of old monopolies or part monopolies by discouraging the launch of new and at least partly competitive undertakings.

Granting the Public Service Commission all possible sincerity of purpose and moral standing, nevertheless (largely because it is a public commission) it has handled the affairs committed to it with non-success unheard of among industrial or commercial corporations—a non-success of method, indeed, that has brought upon the Commission the singular visitation of public censure by a great independent engineering institution and by the general consensus of technical or other experienced criticism. And it has demonstrated little except that when, under fear of favoring industrial capital, construction opportunity is made unattractive, the public is left to do for itself the unprofitable thing.

A Freak of Fortune.

THE voyage of the airship "America" may not unjustifiably be classed with the trapeze act without a net, "the dip of death," or any other spectacle, in which the performer throws dice with death and wins. The intense interest shown in all such events by the masses is perhaps not so cruel as is often assumed. Granted that it is only a step, if so far, from the delight of Roman holiday-makers in a gladiatorial combat; yet the cardinal interest, after all, may not be the actual or possible blood and slaughter, but the triumph of the performer, or of one of the performers, over the Destroyer of Life. Somewhere in the subconsciousness of each of us is the realization that moment by moment a hair line only is drawn between us and the grave. When we see a fellow human recklessly stretch this line to its supposed breaking point, and remain unscathed on this side of it, we (also subconsciously) take to ourselves a certain sense of immunity, or at least a greater security of life. Fallacious it may be; yet here is perhaps the fundamental reason for the fascination of perilous achievements.

From a technical point of view, the attempt was utterly reprehensible and the result a mortifying series of failures to realize anything resembling calculated performances. Indeed, in a province where determinations must be largely empirical, the attempt was made on assumptions wholly theoretical and untested by trial. By such data as are available many of the elements of the project were apparently unsound. It was wholly unproved that the "dirigible" could be directed under probable conditions of mid-Atlantic weather. Zeppelin's experiences indicated that it could neither be directed nor maintained afloat for the time necessary to drift across the ocean. Common-sense suggested that a dragging tail relatively enormously heavy and varyingly submerged in a rough sea would not be an "equilibrator" but decidedly the reverse. Success under peculiarly favorable conditions was not an impossible contingency, but would have proved nothing of value. Mr. Wellman, his companions, and a sympathetic world are to be congratulated that by an almost incalculably fortunate chance there was no tragedy. Atlantic shipping is to be congratulated that the string of flimsy gasolene tanks was not dragged destructively across some luckless vessel, with results too hideous to contemplate. In brief, we may thank God it was no worse.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

RADIATION FROM GASEOUS EXPLOSIONS.

AN INVESTIGATION OF THE HEAT FLOW IN GAS-ENGINE CYLINDERS DUE TO RADIATION.

Bertram Hopkinson—British Association for the Advancement of Science.

THE third report of the Gaseous Explosions Committee of the British Association for the Advancement of Science, presented by Professor Bertram Hopkinson at the recent meeting of the Association in Sheffield, continues the record of the highly important research on gaseous explosions, with special reference to temperature, which was begun in 1907. A year ago we gave in these columns a brief *résumé* of the contents of the first and second reports, and a lucid exposition, from the pen of Dugald Clerk, of the immense practical utility of the data accumulated in the course of the investigation in the solution of the many urgent problems connected with the design of gas engines. These reports gave, it will be recalled, the first accurate set of data by which the temperature of the gases could be calculated from a knowledge of the initial condition of the gas and the amount of heat energy imparted to it by explosion or otherwise. During the session of 1909-1910 the experimental work of the Committee has been continued, by Dugald Clerk, who has continued his measurements of the volumetric heats of air and CO_2 by the method of adiabatic compression; by Prof. H. B. Dixon, who has investigated the temperatures of hydrogen and oxygen produced by adiabatic compression; by Prof. Dalby, who has made measurements by means of an orifice of the air supply to a gas engine; and by Prof. Coker, who will shortly publish further measurements of the temperatures in a gas-engine cylinder. The main work of the Committee, however, has been on the subject of radiation, and Professor Hopkinson's report, briefly abstracted below, is confined to the discussion of this single factor in heat flow.

"In the first and second reports of the Committee reference was made to the part played by radiation in the cooling of the products of an explosion, and to its bearing on the measurements of volumetric and specific heat with which those reports were principally concerned. The general question of radiation from heated gases has, however, from the point of view of the Committee, an interest and importance of its own, which are sufficient to justify a detailed study of it in its wider aspects. Radiation plays a part comparable with that of conduction in determining the heat flow from the gas to the cylinder walls in the gas engine, and it is this flow of heat which is the most important peculiarity of the gas engine, and to which are chiefly due the leading characteristics of its design. The difficulties which the designer has to meet are due, in the main, to the stresses set up by the temperature gradients which are necessary to sustain the flow of heat. In the present state of the art it is probable that the most important service which science could render to the gas-engine constructor would be to establish definitely the principles upon which depend the heat flow from hot gases into cold metal and thus to enable him to predict the effect upon

heat flow of changes in the temperature, density, or composition of the charge, and in the state of the cylinder walls."

As noted above, Professor Hopkinson's report does not attempt to deal with the whole of this large question, but with the single subject of radiation. The subject is a wide one. It has excited much attention among physicists and chemists, and on several important points agreement has not yet been reached. No attempt is made in the report to do more than state briefly the experimental facts, and to define the issues which have been raised with regard to the explanation of these facts. Professor Hopkinson points out that although the discussions on the Siemens furnace and the work of Helmholtz show that the idea that a flame, even if non-luminous, might radiate large amounts of heat, was a familiar one as much as twenty years ago, its possible importance in explaining loss of heat during and after a gaseous explosion, and in determining the heat flow in a gas engine, does not appear to have been appreciated until quite recently. Professor Callendar was probably the first to draw attention to its significance in this connection; he was led to study the subject by his work on the efficiency of the gasoline engine. The particular matter which attracted Callendar's attention was the effect of speed on thermal efficiency. His experiments showed that a part of the loss of efficiency in an internal-combustion motor, as compared with the corresponding air cycle, was independent of the speed at which the engine was run. In 1906 he reported the discovery that a non-luminous Bunsen flame will radiate 15 to 20 per cent. of its heat of combustion, and expressed the opinion that the loss from this cause in a closed vessel explosion would be of the same order.

"Another phenomenon difficult to explain, except as the result of radiation, is the effect of strength of mixture on heat loss. The following table shows some results obtained in tests on a 40 horse power gas engine:—

Percentage of gas in cylinder contents, per cent.....	8.5	11.0
Total heat loss per minute, B. th. u.	1,510	2,300
Total heat loss as percentage of total heat supply, per cent.....	29	34
Temperature of piston, degrees C..	300	430

It will be observed that the proportion of heat loss to the walls increases very materially as the strength of the mixture is increased. If the transfer of heat were wholly due to conduction it might be expected that the percentage of heat loss would rather diminish with increase of charge, because the temperature with the stronger mixture should be relatively less on account of the increase of volumetric heat. The existence of radiation, however, which increases more rapidly in proportion to the temperature, would account for the increased heat flow. The practical importance of questions of this kind is illustrated by these figures, from which it appears that the piston is 50 per cent. hotter, though the charge of gas is increased only 30 per cent.

More direct evidence of the importance of radiation is furnished by experiments on the effect of the surface of the walls. Recently an explosion vessel has been plated with silver on the inner surface, and the results have been compared after exploding identical mixtures, first when the lining was highly polished, and second when it was blackened over with lamp black. It was found that by highly polishing the interior of the vessel the maximum pressure reached could be increased 3 per cent., and the subsequent rate of cooling during its earlier stages reduced by about one-third. These experiments leave no doubt of the reality and of the practical importance of radiation as a factor in determining the heat loss in the gas-engine. By means of a bolometer, Professor Hopkinson has recently made measurements of the radiation emitted in the course of an explosion in a closed vessel and subsequent cooling. He found that the total heat radiated during the explosion of a 15 per cent. mixture of coal gas and air and the subsequent cooling amounted to over 22 per cent. of the whole heat of combustion. The radiation which had been received at the moment of maximum pressure amounted to 3 per cent., and it continued, at a diminishing rate, for a long period. It was still perceptible half a second after maximum pressure, when the gas temperature had fallen to 1,000 degrees C.

There is no reason to suppose that the radiation in the gas-engine cylinder dif-

fers materially as regards its quality or origin from that emitted by an open flame. In a very complete spectroscopic analysis of the radiation from different kinds of flame, the results of which were later confirmed by Helmholtz, Julius found that in all flames producing both CO_2 and steam most of the radiation was concentrated into two bands. It is most probable that the radiation in an explosion consists almost entirely of the same two bands as are emitted by the Bunsen flame; it follows, therefore, that the luminosity of the flame in an explosion or in a gas engine accounts for but little of the energy which it radiates. Much difference of opinion exists as to the physical interpretation of these facts. The issues in the controversy can be stated conveniently in terms of the molecular theory, to a statement of which Professor Hopkinson devoted considerable space. The issues are not merely of theoretical interest, however, but are in large measure issues of fact capable of being tested by experiment, and the answers to important practical questions may depend on the manner in which they are settled.

"The radiation from hot gas is complicated by the fact that the gas is to a considerable extent transparent to its own radiation. The radiation emitted, therefore, depends upon the thickness of the layer of gas, instead of being purely a surface phenomenon, as in the case of a solid body. This property, besides being of great physical interest, is important from the point of view of the gas-engine designer because upon it depends, or may depend, the relative magnitude of radiation losses in engines or explosion vessels of different sizes. The transparency of flames is well illustrated by some experiments which Professor Callendar has been making. . . . . The general result of these experiments is to show that flames of a diameter of 3 centimetres or less burning at atmospheric pressure emit radiation approximately in proportion to the volume. If the diameter be increased beyond that figure the radiation will also increase, but not in proportion to the volume of the flames." The flames met with in a gas engine or in explosion vessels differ from open flames such as can readily be produced in the laboratory, both in respect of lateral extension and also in respect of density. It does not seem possible from theoretical considerations to determine the effect of these two factors with sufficient accuracy to enable any quantitative inference as to radiation in the gas engine to be drawn from laboratory experiments on flames. There is no reason to doubt, however, that the character and amount of the radiation from CO_2 and steam at high temperatures will change with the density. Such direct measurements as have been made of the radiation after a closed vessel explosion suggest that the flame is more transparent than might be inferred from the experiments on open flames. Recent experiments suggest that a thickness of 30 centimetres of flame can transmit much of the radiation which it emits. The density of the gas in that case was atmospheric, and the 30 centimetres thickness in the explosion vessel would be equivalent to perhaps 150 centimetres of open flame if absorption were simply proportional to density. According to Professor Callendar's experiment, such a thickness would be almost completely opaque. It is possible that the lateral extension is sufficient to account for this result. The open flame should be a cylindrical mass, of dimensions 150 centimetres by 150 centimetres, instead of a long strip with a cross section of 3 centimetres, in order to make the cases strictly comparable.

In an appendix Prof. H. L. Callendar discusses the effect of radiation loss on the thermal efficiency. He states that although it is not possible to calculate the absolute magnitude of the radiation loss in a motor, or to deduce from it the relative loss of thermal efficiency, it is not difficult to see in what manner this loss should vary with flame temperature and with linear dimensions of the cylinder. He discusses the subject under various heads, and describes his experiments in some detail. There is also an appendix by Professor Hopkinson on radiation in a gaseous explosion, and another appendix contains abstracts from various papers relating to the application of heat radiation from luminous flames to Siemens' regenerating furnaces.

THE BRIQUETTING OF IRON ORES.

A REVIEW OF THE PRINCIPLES AND METHODS OF BRIQUETTING FINE IRON ORE AND BLAST-FURNACE FLUE DUST.

Chevalier C. de Schwarz—Iron and Steel Institute.

THE problem of fine-ore and flue-dust utilization in iron metallurgy increases in importance year by year. In America, the principal incentive to the wide adoption of briquetting processes in European iron works—the growing scarcity of iron ore in general and lump ore in particular—is not yet seriously felt. Other conditions, however, of no slight importance, combine to make the briquetting plant a desirable, and in some cases a necessary, adjunct to the blast-furnace equipment. The use of improved and more effective explosives in mining has increased the percentage of small and dust ore produced, while at the same time the increased height and higher blast pressure of the modern blast furnace have aggravated the difficulty of dealing with a finely divided charge. On this account, and further because of the growing use of blast-furnace gas for the operation of gas engines, the modern iron works is absolutely limited to the use of ores free from small particles and dust. It is significant of the new conditions that a large plant for the briquetting of flue dust, the first installation in America on the Gröndal system, is now being installed at the Duquesne works of the Carnegie Steel Company.

Briquetting processes are described in a paper read by the Chevalier C. de Schwarz at the recent meeting of the Iron and Steel Institute. It is quite apparent that we are still very far from having a perfect and universally applicable system. Some methods have proved successful only for certain kinds of ore, or in purely local conditions. Experience has shown that the method to be adopted must be designed to suit not only the physical condition of the ore but also its chemical composition. Most of the methods proposed have proved too expensive, directly in first and operating costs, and indirectly in the reduction of the iron content of the ore by the addition of binding material.

The conditions which iron-ore briquettes should fulfil are seven: (1) they must be capable of resisting a mechanical pressure of not less than 2,000 pounds per square inch, and when dropped from a height on a cast-iron plate, they must not fall into dust, although they may break in pieces; (2) they must resist heat; at 900 degrees C. they may commence to sinter but must not disintegrate into small fragments; (3) they must be capable of being placed in water for a considerable time without softening; (4) they must resist the action of steam at 150 degrees C. without crumbling; (5) they must be to a certain extent porous, in order to allow the carbon monoxide in the blast furnace to penetrate the interior of the briquette and to exercise its beneficial reducing influence; the porosity is tested by placing the dried briquettes for about 25 minutes in water; they should absorb in this time not less than 12½ to 16 per cent. of water, according to the nature of the ore; (6) if a binding medium is used, it should not contain impurities, such as sulphur or arsenic, in quantities likely to injure the quality of the pig iron produced; and finally, (7) the cost of producing briquettes should not exceed the difference in price between lump ore and fine ore.

Briquetting processes may be divided into those in which a binding medium is used, and those in which no binding medium is used; and the first class may be subdivided according to whether the binding medium is inorganic or organic. Dealing first with the class of processes in which no binding medium is used, except in the case of ores which contain a certain percentage of clay, in itself a binding medium, the briquettes have to be heated at considerable expense. The satisfactory results obtained in briquetting bean ore and clay iron stone by pressure alone at Kertsch, in Russia, and Ilsede, in Germany, naturally suggested the use of clay as a cheap binding medi-

um which would do away with the necessity of heating the briquettes. It has been found, however, that so comparatively large a percentage of clay is necessary as unduly to reduce the iron content of the ore, besides requiring additional limestone in the furnace, and this method of briquetting has been abandoned except in localities where ferruginous clay is available. The attempt to avoid both the use of binding medium and the necessity of heating the briquettes by employing very high pressure, up to 11,000 pounds per square inch, has not been successful; the briquettes made in this way, while firm and strong, are too dense, and crumble when exposed to heat.

Of the processes of briquetting without binding medium, by heating the briquettes after they have left the press, the Gröndal has proved most successful for magnetic ores. The concentrates from magnetic separators, containing from 67 to 71 per cent. of iron, are moistened and made into round-edged briquettes about 6 inches square and 2½ inches thick. The briquettes, set on edge on small iron wagons, are placed in a furnace heated by producer and blast-furnace gases and supplied with a sufficient quantity of heated and compressed air to produce a strongly oxidizing flame, whereby the magnetic ore (Fe_3O_4) is oxidized to peroxide of iron (Fe_2O_3), while at the same time the sulphur is considerably reduced. The capacity of a furnace 150 feet long and 5½ feet wide is about 200 tons of briquettes per week, at a cost, exclusive of general expenses and royalties, of 3s. 4d. per ton. The briquettes are hard and porous and are well suited to the blast furnace.

The comparatively high cost of the Gröndal process has prevented its adoption to any great extent outside of Sweden. In Sweden, however, because of its special adaptability to the prevailing iron-making conditions, the Gröndal process is widely employed, the 27 furnaces now in operation having an annual output of 300,000 tons. Swedish iron-making practice is based almost entirely on the use of charcoal in the blast furnace. The acid slag of charcoal furnaces does not absorb sulphur, but allows nearly all the sulphur in the ore to pass into the pig iron. On this account, Swedish iron masters object to the use of ore containing more than 0.015 per cent. of sulphur; the popularity of the Gröndal process is largely due to the expulsion of a large proportion of the sulphur remaining in the concentrates by the oxidizing flame and high temperature (1,400 degrees C.) of the briquetting furnace. Although the percentage of iron in the briquettes is somewhat reduced by the transformation of the magnetic oxide into peroxide of iron, this disadvantage is more than compensated for by the removal of the sulphur, and also by the fact that the reduction of the peroxide in the blast furnace is accomplished with less fuel than is required to reduce magnetic oxide. The growing scarcity of charcoal in Sweden is another consideration in favor of the use of the Gröndal process. Taking equal weights and percentages of iron in each case, briquettes of magnetic oxide require 300 pounds of charcoal more per ton of pig iron than briquettes of peroxide, representing an additional cost of about 6s. 6d. per ton of pig iron.

The use of briquettes made of concentrates directly in the open-hearth furnace, as a decarburizing and enriching addition to the molten metal, has been suggested. The concentrates made by the Gröndal process in Swedish practice amply fulfil the conditions of quality and purity established for ore additions to the open-hearth furnace charge. It is unnecessary, therefore, in making briquettes for this purpose to heat them up to 1,400 degrees C. for the complete expulsion of the sulphur, nor is it necessary either to oxidize the iron from Fe_3O_4 to Fe_2O_3 or to make the briquettes porous. The briquettes may be compressed at a considerably higher pressure than when designed for blast-furnace charging, and the heating need not be carried above 800 to 900 degrees C., at which temperature Fe_3O_4 commences to sinter. Briquettes for use in the open-hearth furnace are considerably cheaper and richer in iron than those used in blast-furnace practice.

In order to avoid the cost of briquetting, an agglomeration process has been

devised which seems to be of especial value in cases where the agglomeration can be advantageously combined with a roasting action, as in the case of spathic ore, brown ore, or iron ore containing a high percentage of sulphur. The process is carried out in a rotary kiln. Coke dust mixed with the fine-grained ore to be agglomerated reduces a part of the Fe_2O_3 to FeO, at once enriching the ore in iron and reducing the temperature necessary for agglomeration. The process, however, presents two serious difficulties: first, the difficulty of regulating the temperature so as to produce sintering without melting, and, second, the tendency of the ore, as soon as it commences to agglomerate, to form scaffolds by adhering to the inner fireproof lining of the furnace. The difficulties are more pronounced when coal dust is employed for heating the furnace, because the tendency of the ore to form scaffolds is increased by the addition of the silica and alumina in the ash. The use of gas fuel may remove this difficulty, and at the same time may make the regulation of the temperature a more simple matter.

One of the earliest materials used as a binding medium for iron-ore briquettes was slaked lime; it has been found that satisfactory briquettes can be made when the lime is mixed with some granulated basic slag, but for various reasons the process has been little used. The 7 or 8 per cent. of binding material necessary considerably reduces the percentage of iron in the briquettes, but the most serious drawback of the process is the expense of space and labor for the storage of the briquettes in the open air until the calcium oxide absorbs sufficient carbon dioxide to prevent the briquettes from crumbling in the blast furnace through the dehydration of the hydrate of lime.

Burnt lime, gypsum, and cement also have been tried, but without success. A mixture of sand and slaked lime has been more satisfactory. The briquettes, consisting of fine-grained ore intimately mixed with 6 per cent. of these materials in equal proportions, are exposed for some hours to the action of superheated steam under pressure, after which they are ready for the blast furnace. The silica is changed by this treatment from the insoluble to the soluble condition, ready for combination. Technically the process is very successful, but the high cost both of plant and of operation has prevented its wide adoption. A similar method of briquetting, based on the same principle, uses basic blast-furnace slag as binding medium, but the quantity of binder required to make a satisfactory briquette (10 per cent.) unduly reduces the percentage of iron. Spathic iron ore mixed with lime is successfully used in the same manner, but this process also is too expensive for wide adoption. This process is based on the fact that under steam pressure the mixture is changed into hydrated ferrous oxide and carbonate of lime. The former, being of a gelatinous nature, serves as a binding medium and changes later on into hydrated sesquioxide of iron. The spathic ore and lime are mixed in the proportion of two to one, and 15 per cent. of this mixture is added to the ore to form the briquettes. When spathic ore alone is to be briquetted, an addition of 6 per cent. of lime alone is sufficient.

The success achieved in briquetting blast-furnace flue dust is largely due to the fact that the dust itself, composed, like cement, of lime, alumina, and soluble silica, possesses hydraulic properties. By the addition of certain salts, such as the chlorides of magnesium and calcium, green vitriol, or sulphuric or hydrochloric acids, these hydraulic properties may be intensified to such a degree that they may be utilized for the formation of briquettes. Of these materials, chloride of magnesium, used in the Schumacher process, has been found to be the most suitable, because of both its cheapness and its freedom from deleterious elements. The Schumacher process has given very satisfactory results, both technically and commercially. It may be pointed out here that flue dust must be used almost immediately after its removal from the catchers, and that, like cement, it must be protected against humidity before briquetting. Basic blast-furnace slag which has been exposed to steam pressure, to change the silica from the insoluble to the soluble state, is another binding medium which produces satisfactory briquettes of flue dust. The

silica of the slag combines with the lime of the dust to form a kind of cement; in case the quantity of lime in the dust is insufficient, another 4 or 4½ per cent: is added. This process, however, is open to the objection that the 8 to 12 per cent. of binding material used reduces the iron content of the briquettes to a point where briquetting becomes unprofitable.

Of organic material, waste lye, a by-product of the manufacture of sulphide cellulose, and molasses have been used for briquetting both flue dust and ores. About 6 per cent. of the lye, concentrated to a sort of pitch, is intimately mixed with the dust or ore and the mixture pressed into briquettes under a pressure of about 9,000 pounds per square inch. The briquettes are entirely satisfactory, but the cost of the binding medium is too high to promise financial success to the process. Molasses has been used for briquetting the ferri-ferrous residues of the aniline manufacturing process, as well as for the briquetting of flue dust and ore. One part by volume of cheap molasses, two parts of Kieselguhr, 0.4 parts of carnalite, and 100 parts of ore, from the briquette mixture. The briquettes, after drying in the open air, are heated in an annular furnace to 1,000 degrees C., at which temperature they begin to sinter and harden. For briquetting aniline by-products, which contain about 67 per cent. of iron, the process is entirely practicable; for other purposes it is entirely too expensive.

In conclusion, M. de Schwarz gives some data of the costs of the various processes described. The Kertsch and Ilsede methods cost about 1s. per ton of briquettes; the Gröndal process, 4s. 8d. including royalty; the Schumacher process, which has given the best financial results for flue dust, 1s. 8d. per ton without royalty; the less important processes, from 2s. 6d. to 3s. 9d. per ton. M. de Schwarz doubts that a universal process fulfilling the conditions enumerated at the beginning of this review will ever be invented. He mentions, however, in his concluding paragraph, a new process to be used at a Belgian works, which gives promise of being more economical than any yet introduced. It is said that the binding medium, of which 2½ to 4½ per cent. is used, costs about 16s. per ton. The first cost of plant is about £2,500, and the cost of manufacture, including general expenses, about 1s. 6d. per ton. The briquettes fulfil all the conditions referred to, and are ready for use within 24 to 36 hours after leaving the press, without heating or further treatment. The method is applicable to mill scale, as well as to fine ores. Further details of this very promising process will be awaited with interest.

AN ELECTRO-MAGNETIC TRANSMISSION FOR MARINE TURBINES.

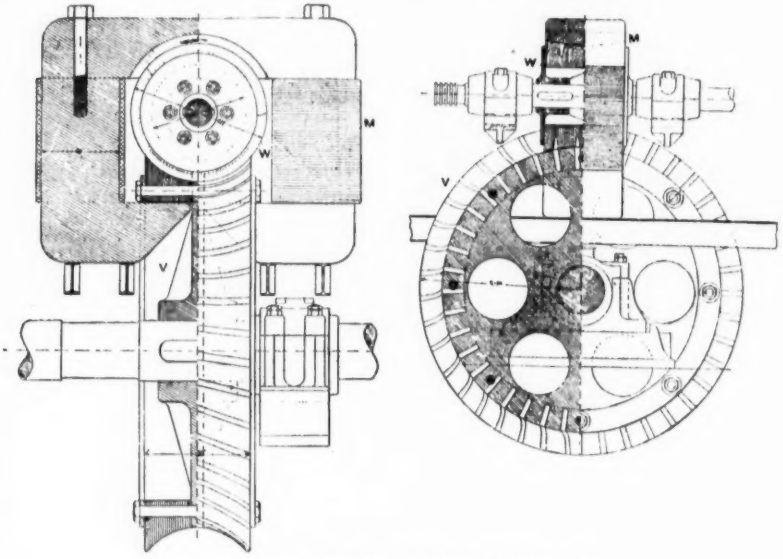
A BRIEF DESCRIPTION OF A NEW GEAR FOR SPEED REDUCTION AND POWER TRANSMISSION IN MARINE TURBINE PROPULSION.

Jules Lecoche—Institute of Marine Engineers.

IT is just a year since we described in these columns the Melville-Macalpine-Westinghouse double-helical spur gear for transmitting to the propeller shaft at a reduced speed the power of marine steam turbines. Later we described the Föttinger hydraulic gear designed for the same purpose, and more recently still another mechanical gear, the invention of the Hon. C. A. Parsons. Another solution of the marine turbine problem is now offered by Jules Lecoche, who has described an electro-magnetic system of power transmission and speed reduction, invented by him, at a recent meeting of the Institute of Marine Engineers. The diagram and data below are taken from a reprint of his paper in the *Mechanical Engineer* for September 23.

According to M. Lecoche, the gear is especially applicable to the combination of reciprocating engine and low-pressure turbine, which experience has shown to be the most economical system of marine propulsion. "The diagrams show a magnetic frictionless gear of the screw type for an exhaust-steam turbine of 300 brake horse power running at 3,000 revolutions per minute; through this gear the power of the turbine is transmitted

to the main propeller shaft driven by the reciprocating engine at a speed of 75 revolutions per minute. Such a high-speed reduction is possible in this case, owing to the fact that the absence of friction between the working parts allows such high circumferential velocities as would be quite impracticable with mechanical gearing; besides, apart from the bearings, there is no need for lubrication, and this is a point not to be despised. Unlike an electric motor, the revolving parts of the magnetic gear carry no winding whatever, so that the empty slots and helical grooves of both wheel and worm provide for a perfect cooling. The three main parts of the gear are the field magnet M, the laminated worm W, the wheel V.



SECTIONS OF A 300 HORSE-POWER MAGNETIC GEAR.

"The field magnet, made of cast steel of high magnetic permeability, is of the Manchester type; its top pole-piece is laminated in order to prevent losses and heating from hysteresis and Foucault currents. The coils are wound with high conductivity copper wire properly insulated. The worm is made up of iron stampings fixed concentrically on two cast-iron spiders, in exactly the same way as the armature core of a motor or dynamo. One end of the worm shaft is coupled to the turbine. The end-thrust is either entirely or partially balanced by that of the turbine. A thrust-bearing is shown at the other end of the shaft to take the unbalanced thrust. The wheel, being subjected to a side-thrust due to the angularity of the teeth, partially relieves the thrust blocks of the propeller shaft. The wheel V has a hollow rim made up of sprockets of soft iron coarsely laminated; these sprockets have the same angle, width and pitch as the threads of the worm opposite which they move with a clearance of about ¼ inch. This wheel is keyed on the propeller shaft driven by the reciprocating engine at 75 revolutions per minute. To clearly understand how the tangential pull on the rim of the wheel is obtained by means of apparently perpendicular lines of force, it must be pointed out that the latter are not actually normal to the circumference of the wheel, but, owing to difference in the degree of saturation of the iron sprockets due to a slight advance of the worm threads under load, the lines of force cross the air gap at an angle, dragging the wheel in the same way as the armature of an electric motor

is pulled back into the field when shifted along its center line.

"The transmission losses are the electrical energy necessary for exciting the magnetic field and the hysteresis and Foucault currents in the iron of the worm and wheel. From experiments I have made, I found that a magnetic density of 15,000 lines per square centimetre is required to give a tangential force of 22 pounds per square inch of iron face. With a total air gap of one centimetre, a number of ampere-turns equal to 800 × 15 = 12,000 is required for producing the necessary magneto-motive force. As there are two parallel magnetic circuits (wound in series) it will really be 24,000 ampere-turns, to which we must add 6,000 ampere-turns to overcome the resistance of the iron circuit, and this brings the total to 30,000 ampere-turns. Let us now assume that the pressure of the electric supply is 120 volts, that the wire with which the coils are wound has a sectional area of .012 square inch, to which corresponds an ohmic resistance of 2 ohms per 1,000 yards, and that we allow a current density of 1,000 amperes per square inch, say, 10 amperes for the section of our wire; then, 3,000 turns of such wire will be necessary to give the 30,000 ampere turns required. The length of each turn of wire being 2 yards, the total length of the electric circuit will be 6,000 yards, whose total resistance (at 2 ohms per 1,000 yards) is 12 ohms. The formula R × I = E, in which R is the resistance of the circuit, I the intensity of the current, and E the electro-motive force, is verified: 12 ohms × 10 amperes = 120 volts. The total electrical energy corresponding to these figures is: 10 amperes × 120 volts = 1,200 watts, which is less than 1 per cent. of the total power transmitted (300 horse power). Owing to the laminated state of the worm, and also the sprockets of the wheel, the loss through eddy currents and hysteresis is very low and always less than 4 per cent. of the total power, which, added to the 1 per cent. of the field excitation, will give a total loss of 5 per cent.

"The total weight of the 300 brake horse-power gear for reducing the speed from 3,000 revolutions to 75 revolutions per minute is 11 tons, of which two tons is for the worm with its shaft and bearings, four tons for the wheel and five tons for the field magnet. Comparing these figures to electrical transformation, it would be in the latter case: One 250 kilowatt dynamo at 3,000 revolutions per minute, three tons (approximately); one 300 horse-power motor at 75 revolutions per minute, 27 tons (approximately); total, 30 tons. The magnetic gear can run in both directions if the turbine is reversible; if such is not the case, the excitation is cut off by means of a switch, and the reciprocating engine gives alone the reverse motion without the assistance of the turbine."

POWER CONSUMPTION OF STEAM AND ELECTRIC HOISTS.

RESULTS OF TRIALS OF GERMAN STEAM AND ELECTRIC HOISTS, SHOWING THE COMPARATIVE POWER CONSUMPTION OF VARIOUS TYPES.

Glückauf.

SOME time ago a committee was appointed by the joint action of the Society of German Engineers, the Association for the Protection of Mining Interests, and the Dortmund Boiler Inspecting Association, for the purpose of carrying out exhaustive experiments on the consumption of power in hoisting engines, with a view to establishing comparative data of the economy of the various types. The experiments were divided into two classes: one series extended continuously over a certain period of time; the second series consisted of isolated measurements. A preliminary report summarizing the data obtained in the first series has been published in *Glückauf* for August 27. The accompanying table, rearranged from a translation of this report printed in the *Colliery Guardian* for September 30, gives the results of the trials of four electric and five steam hoists, all of them serving collieries in the Dortmund district.

With reference to the table, "useful load" is the difference between the raised

STEAM HOISTS.

Colliery	Schürbank and Charlottenburg, Aplerbeck.	Julia, No. 2 shaft, Herne.	Helene and Amalie, Amalie Shaft, Essen-West.	Wilhelmine Viktoria, Shaft 1, Gelsenkirchen.
Data of hoisting plant:				
Type of engine	Twin tandem	Twin tandem	Twin tandem	Two-cylinder
Cylinder diameter, inches	2 by 34/50	2 by 34/50	2 by 28/48	2 by 42
Stroke, inches	78¾	78¾	63	78¾
Type of electric plant	.....	.....	.....	.....
Capacity of Ilgner motor, horse power	.....	.....	.....	.....
Weight of flywheel, tons	.....	.....	.....	.....
Normal capacity of motors, horse power	.....	.....	.....	.....
Type of driving pulley	Cylind. drum	Cylind. drum	Koepe pulley	Koepe pulley
Diameter of ditto, inches	315	315	275	256
Weight of cage and fittings, tons	6.59	6.375	6½	4.2
Number of decks per cage	8	4	3	4
Number of cars per cage	8	8(each 2 end on)	6(each 2 end on)	8(each 2 end on)
Useful load per normal trip, tons	5.431	4.205	3.282	4.576
Weight of top rope, pounds per yard	19⅝	21½	19⅝	15
Weight of tail rope, pounds per yard	19⅝	21½	19⅞	15
Number of times rope taken up	3 and 7[a]	3	2	3

Results of trials: Length of trial	7 hrs. 55 mins. (main shift)	24 hrs. (main shift)	7½ hrs.	24 hrs.	8 hrs. (main shift)	8 hrs. (main shift)	8 hrs. (main shift)	24 hrs.
Load raised, tons	1,598	1,906	1,724	3,469	1,120	1,226	1,560	1,616
Load lowered, tons	485	627	745	1,569	396	468	583	628
Useful load, tons	1,113	1,279	979	1,900	724	758	977	988
Height of hoist, yards	660	660:656[a]	448	448	602	602	664	664
Number of trips	202	282	260	600	217	240	210	302
Mean velocity, yards per second	12	...	9½	...	10⅜	10⅝	12	...
Mean useful load per trip, tons	5.510	4.535	3.765	3.167	3.336	3.159	4.652	3.272
Mean output of energy, shaft horse power	313.8	119.2	197.9	119.7	185.6	194.4	274.5	92.6
Admission pressure, atmospheres	11.2	10.9	9.2	9.2	7.1	7.2	7.4	7.3
Degree of superheating, degrees C.	218	200	Saturated steam.		Heat accumulator.		Saturated steam.	
Vacuum, per cent	74.0	76.3	Exhaust.				Exhaust.	
Calculated total steam consumption, pounds	89,838	151,470	85,377	195,600	80,696[c]	78,793[c]	102,080	146,837
Steam consumption per shaft horse power, pounds	36.3	53	59	68	44.3[c] & [d]	50.64[c]	46.48	61.16
Working tension of polyphase current, volts	....	....	....	....	....	....	....	....
Total electric energy absorbed, kilowatt-hours	....	....	....	....	....	....	....	....
Consumption of energy per shaft horse-power, kilowatt..	....	....	....	....	....	....	....	....

[a] Three times during main hoisting shift, seven times during the remaining period. [b] With exhaust-steam turbine attached. The figures for the twenty-four hours' test are of no value for comparison, and have therefore been omitted. [c] The values are rather too favourable, the condensed water in the intermediate receiver and engine being measured, and deducted, with that in the live-steam pipe. [d] The corresponding efficiency of the exhaust-steam turbine could not be determined, the exhaust steam of the hoisting engine being insufficient to keep the turbine in work, so that exhaust steam from other engines had to be drawn upon. The steam consumption of the exhaust-steam turbine was: under full load, 30,443 pounds for 740 kilowatts per hour = 41⅛ pounds per kilowatt-hour; and under half-load, 17,032 pounds for 350 kilowatts per hour = 48.66 pounds per kilowatt-hour.

load and the lowered load. In a "normal trip" the ascending cage is filled with loaded cars, and the descending cage with its full complement of empties. The weights of the full and empty cars are mean figures, determined from a large number of single cars. The "height of hoist" is the depth of the main haulage level. In occasional hoists from other levels the corresponding height of hoist has been included in the calculation. The "calculated steam consumption" is the difference between the weight of the boiler feed water and that of the water of condensation from the steam pipes.

In the course of the investigation, the committee arrived at the conviction that the usual method of testing engines at the time of taking delivery from the makers is unsuitable as a basis for reliable comparative data on the different types of engine, since it does not allow

Electric Hoists.

Deutscher Kaiser, Shaft V. Hamborn.	Rheinelbe, Shaft II, Gelsenkirchen.	Mathias Stinnes III./IV., Shaft 3, Brauck. Machine No. 1.[b]	Mathias Stinnes III./IV., Shaft 3, Brauck. Machine No. 2.[b]	Emscher-Lippe, Shaft 2, Datteln.
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
Ilgner	Ilgner	Ilgner	Ilgner	Ilgner
765	1,000	500	500	1,440
49	52	40	40	Two of 40
Two of 510 Koepe pulley	Two of 750 Koepe pulley	Two of 550 Koepe pulley	Two of 550 Koepe pulley	Two of 950 Koepe pulley
315	276	255	255	252
8	6½	8¼	7⅛	5¾
4	4	4	6	4
8 (each 2 end on)	8 (each 2 end on)	8 (each 2 end on)	6	8 (each 2 end on)
4.374	4.554	5.456	4.092	6.352
21¼	18⅜	28¼	21	18½
21⅛	17½	18⅜	18¾	18¾
3	3	3	3	3

8 hrs. 54 min. (main shift)[a]	24 hrs.	7¼ hrs. (main shift)	24 hrs.	8 hrs. (main shift)	24 hrs.	8 hrs. (main shift)	24 hrs.	8 hrs. (main shift)	24 hrs.
1,245	2,285	2,302	4,417	1,297	1,370	558	1,666	2,785	5,566
570	1,020	760	1,725	601	693	236	708	983	2,055
675	1,265	1,442	2,692	696	677	322	958	1,802	3,511
414	414	403	403	585	585	585 : 420[c]	585 : 420[c]	733	733
188	365	294	578	157	232	94[c]	305[c]	284	608
8.85	...	9.18	...	8.2	...	8.1[d]	...	12.1	...
3.59	3.466	4.904	3.970	4.431	2,917	3.421	3.140	6.345	5.774
106.2	73.8	262.7	153.4	172	55.9	72.9	76.3	559	363.4
....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....
5,000	5,000	5,000	5,000	Machine	5,000	Machine	5,000	3,000	3,000
2,330	4,777	3,290	7,476	I. and II.	3,850[f]	I. and II.	8,454[f]	6,217[h]	13,571[h]
2.47	2.70	1.67	2.03	in 8 hrs.	1.97[f]	in 8 hrs.	2.66[f]	1.39[h]	1.56[h]

[a] In this case, hoisting the men in the morning is included. [b] The two Ilgner units were coupled mechanically. [c] 28 trips from a depth of 420 yards. [d] Wound from a depth of 585 yards. [e] 37 trips from a depth of 420 yards. [f] These figures are rather too unfavourable, since the compressor (consuming about 25 kilowatts, for which no deduction has been made) for the hoisting brake was worked in parallel with the compressed-air main of the pit. [g] As a rule, two coupled Ilgner units, each with a 40-ton flywheel, work both hoists in No. 2 shaft. In the trial the one unit was run with both flywheels. [h] The figures are rather too favourable, the compressed air for the pneumatic brake being drawn from the general compressed-air main, without any addition being made to the figures to allow for this.

properly for the influence of the depth, useful load, and general working conditions, the lowered loads, for instance, being insufficiently taken into consideration. Moreover, and especially in the case of the steam hoists, the manner in which the engineer operates his engine has a determining influence on the consumption. It was these considerations which led to the making of the isolated measurements, which consisted in observing single trips with weighed loads and at different prescribed velocities. These trials are not yet completed, so that it cannot be stated with certainty whether they will furnish the desired new basis of comparison to supersede the present standard, the amount of energy consumed per shaft horse power. We shall hope to present data on this point upon the appearance of the final report of the committee.

THE TESTING OF FILES.

A BRIEF DESCRIPTION OF THE HERBERT FILE-TESTING MACHINE, AND OF AN IMPROVEMENT DESIGNED TO BRING ITS ACTION CLOSER TO PRACTICAL CONDITIONS.

Prof. W. Ripper—British Association for the Advancement of Science.

BEFORE the introduction a few years ago of the file-testing machine invented by Edward G. Herbert, whose machine for testing the durability of tool steels has been referred to in these columns more than once, no method of testing quantitatively the cutting power of files was available. The file purchaser was obligated to rely entirely on the reports of durability furnished by more or less skilled workmen. The Herbert machine sprang into immediate popularity, and many large purchasers of files adopted the practice of specifying a certain standard of durability to be determined by the machine. It was not long, however, before doubt was cast upon the accuracy of the results obtained by this method of testing, because of the glaring anomalies observed in the test records. Files considered to be of the best quality gave poor results in the testing machine; great differences of cutting power were recorded of files supposed to be in all respects alike; and differences in cutting power of as much as 10 to 1 were commonly recorded of the two sides of the same file, even among the best makes. A general demand for an investigation of the accuracy of the results given by the machine led to a series of experiments conducted by Prof. W. Ripper, of Sheffield University, whose description of the Herbert machine and the modifications suggested by him, read at the recent meeting of the British Association for the Advancement of Science and printed in the *Mechanical Engineer* for September 23, is briefly abstracted below.

"The action of the Herbert file-testing machine is briefly as follows: The file to be tested is held rigidly between two headstocks on a reciprocating table. The test bar is supported in a horizontal position on grooved rollers, and is pressed against the file by a weight in the front of the machine, attached by a chain passing on rollers under the bar by a clip to the outer extremity of the bar. By the reciprocating motion of the file acting on the end of the bar a portion of the bar is cut away each stroke, the amount of which depends upon the quality of the cutting power of the file under test. The file cuts on the forward stroke. On the backward stroke, the bar is drawn out of contact with the file by means of an ingenious clutch lever acting after the manner of a spanner. At the beginning of the forward stroke the bar is released from the clutch, and by means of the weight previously mentioned it is pressed against the bar with a pressure of 30 pounds per square inch. Heavy weights suspended from the reciprocating headstock rest against the back of the file in order to prevent chattering and jarring of the file, which would otherwise occur.

"The recording gear attached to the machine consists of a large drum round which is wrapped a diagram sheet of squared paper. The drum rotates very slowly by a reducing gear driven from the crank shaft, and permits of a line being drawn in a direction parallel to the base, and representing the number of strokes made by the file. A movement of the pencil at right angles to this is made to record the amount of material filed away from the end of the test bar. This movement is obtained by a connection between the pencil and the moving bar, the sliding forward of the bar as it becomes shorter giving the motion required to the pencil. By means of the two movements here described a curve is drawn representing the number of inches filed from the bar and the number of strokes made by the file in performing the work recorded. The slope of the curve indicates the rate of cutting, or sharpness of the teeth of the file, and the curve shows clearly how the rate of cutting falls off as the file deteriorates, until, when the file is worn out, the line becomes parallel to the base of the drum."

Prof. Ripper's tests were not long in demonstrating that the machine "differs

in its action from hand filing in one important direction, namely, that in the machine the file moves across the face of the test bar through an absolutely constant path, the respective teeth of the file each stroke working in identically the same grooves or furrows on the face of the test bar stroke after stroke. The result is that the face of the work occasionally becomes glazed in appearance, and the file ceases to cut, though the file itself may not be worn out. In the case of hand filing no two strokes are made exactly in the same direction. The conditions, therefore, under which the tests are made in the machine differ from those under which the file is worked in actual practice, and this difference works to the disadvantage of the file.

"With a view to determining the effects of revising the machine so as to make it approach more nearly to the conditions of hand filing, Prof. Ripper has devised an addition to the Herbert machine by means of which the path of the file is no longer a constant one, but slightly changes its direction stroke by stroke, as in the case of hand filing. To secure this, the file is no longer held rigidly at its two ends, but is connected by ball joints, the effect of which is equivalent to that of a wrist movement at each end of the file. The variation of the path of the file is obtained by slightly shifting the position of one end of the file relatively to the other end by a simple mechanism secured to the reciprocating headstock. The change of position is made during each return stroke, so that on the following working stroke the file moves in a different path from that which it had in the preceding stroke.

"The ball joint at the tang end of the file is fixed to the reciprocating head, merely permitting a movement about its own centre. The ball joint at the opposite or outer end of the file is also carried by the reciprocating table. This ball joint travels in a small circular path, 1/16-inch radius, in a plane at right angles to the axis of the file. The small rotating movement of this outer ball joint is obtained by turning the socket out of the disc which holds the ball, so that the socket has 1/16-inch eccentricity relatively to the centre of the disc itself which carries it. On the edge of the disc so constructed, worm wheel teeth are cut, gearing with a worm in such proportion that the worm wheel rotates once for every 48 double strokes of the file, or, in other words, there is a change of position each double stroke of 1/48th of a revolution of the outer ball joint, about the centre of the disc which contains it. The disc and worm gear are carried by the outer reciprocating headstock.

"A further problem was how to convert the reciprocating motion of the table into a rotating motion of the worm wheel in one direction only. This is accomplished by fixing on the axis of the worm a bicycle free wheel with teeth on its outer edge gearing with a chain fixed between two stationary points of attachment. Then when the table reciprocates, the wheel runs free in one direction and grips the worm spindle in the other, resulting in the rotation of the worm always in one continuous direction, the worm rotating during one stroke and remaining free during the opposite stroke."

The use of this apparatus in the large number of tests made by Prof. Ripper almost entirely removed irregularity from the results of tests on files of similar quality. The results show also that the difference in cutting power between the two sides of the same file is not great. The tests were made up to a limit of 40,000 strokes for each test. It is possible that a prolongation of the test until the file entirely ceases to cut might modify the results. In Prof. Ripper's opinion, however, durability tests "should not be carried on till the file entirely ceases to cut, but should be carried rather to where the file would, in ordinary practice, be considered unfit for further use, which condition would be reached when the rate of cutting has fallen to, say, one-fourth of the standard of cutting required for the sharpness tests. It seems desirable also to allow a weight of 30 pounds during the first portion of the test in order to determine cutting power, and then to increase the weight, say to 50 pounds, for the remainder of the test, which might then be considered a separate durability portion of the test. In this way much time would be saved.

"It will be noticed that this mechanism amounts to a movement of the centre line or axis of the file in such a way that the axis describes a cone, which is its apex at one end and its base at the other end, the length of the axis of the cone being equal to the length of the file, and the diameter of its base ⅛-inch. The face of the file is in the two extreme horizontal positions of the ball joint slightly inclined to the face of the work, its plane of motion moving about an axis passing through a guide point.

"It may be contended that the arrangement now proposed is equivalent to adding additional weight to the bar, because alteration in the position of the file relatively to the face of the bar tends to cause the file to bear on a portion only of the area of the face, and not to cover the whole area, and thus the pressure per square inch between file and face is increased. To what extent this is true depends entirely upon the rate at which the change of position of the file takes place. Its change of position can be made to occur so slowly that the file bears over the whole area of the surface every stroke. The rate as at present arranged is one small cycle of movement every 48 double strokes, and this seems a satisfactory rate, because it does not appear from the diagrams that the rate of cutting under these conditions is greater than under the old conditions. The only difference is that with the new method of cutting abnormal results disappear, and the curves obtained for the same make of files, or for the two sides of the same file, are generally remarkably similar and regular in character.

"The feature of the mechanism and the principal point to be secured is a change of direction of motion of the file stroke by stroke instead of a constant repetition of the same path. It is plainly possible to give the file such a motion in one plane only by giving it a slight rocking motion in a vertical plane without any sloping whatever of the face of the file in relation to the work. The objection of the reduced area, and therefore increased pressure per square inch, would then be removed entirely. The present arrangement, however, gives the file an excellent chance to do its best."

SPEED REGULATION OF STEELWORKS MOTORS.

A REVIEW OF RECENT SYSTEMS OF SPEED REGULATION APPLICABLE TO ALTERNATING-CURRENT MOTORS.

J. J. Elink Schuurman—Iron and Steel Institute.

IN the large modern steelworks, alternating current has practically superseded direct current for the various applications of electric driving. Early applications of electric power were on a small scale, to which continuous current was well suited. But with the gradual extension of the electric drive, which in the most modern plants is applied to practically every purpose requiring power, the increasing distance of transmission made continuous-current distribution more and more uneconomical, until finally its use was abandoned except in small installations. It is only recently, however, that a most important disadvantage of the alternating-current system in comparison with the direct-current system has been removed. This is in the matter of motor speed regulation. The continuous-current motor is well adapted to simple and economical speed regulation, but before the invention of the three systems described below, after a paper read by J. J. Elink Schuurman at the recent meeting of the Iron and Steel Institute, the regulation of alternating-current motors could be obtained only by very wasteful methods.

In speed regulation in a definite direction of rotation, a distinction must be made between the adjustment of different no-load speeds with a slight drop of speed between no load and full load, the adjustment of different no-load speeds which drop to a certain adjustable extent between no load and full load, and a regulation which causes a large drop of speed when the load is applied, but does not permit of adjusting at various no-load speeds. Further, it is often required that the output should remain

constant at all speeds, although a constant torque over the entire range of speed regulation is generally sufficient.

Which of these different forms of regulation are applicable to the different operations in iron and steel works? For rolling mills it is often necessary to obtain different no-load speeds, depending on the rolling programme. The type of mill will determine whether these speeds should remain constant from no load to full load (wire mills and others where the load remains fairly constant), or whether a drop of speed is required (blooming and similar mills in which considerable peak loads are experienced). An interesting phase of the speed-regulation problem is presented by the high-speed rotary blowers which are gradually replacing reciprocating blowers in blast-furnace plants and steelworks. When the speed is constant, the rotary blower produces a pressure which is practically independent of the volume of air delivered. A change of pressure can be obtained by varying the speed, and as the pressure increases approximately with the square of the velocity, comparatively small alterations in the speed will suffice to produce the necessary pressure variations. When the blower is electrically driven, a high-speed motor must, of course, be used, and except in special cases the motor must be capable of easy and economical speed regulation. The requirements of blast-furnace blowers are comparatively easy to meet. Steelworks blowers, however, are called upon to supply pressures from 5 to 35 pounds per square inch, as well as widely varying volumes of air; the driving motor must be capable of a wide range of speed regulation, preferably of the type in which the speed, once adjusted, does not vary between no load and full load.

The three-phase induction motor, which is most extensively used for electric driving in steelworks, possesses the great advantages of simplicity and safety of operation, but in its original form the speed, which depends upon the number of poles and the frequency of supply, cannot be economically regulated. The simplest means of speed variation, the insertion of an adjustable resistance into the rotor circuit, has often been used for regulating the speed of rolling mills, but is very uneconomical because an amount of energy, proportional to the percentage of the regulation, is lost in the slip resistance. Another disadvantage of this method of regulation is that for an adjusted slip resistance, the speed changes to a very great extent with variations of the load, and rises to practically its normal value at no load. This running back to the synchronous speed can be of great inconvenience in the operation of rolling mills, as it is just when running light that a low speed is required in order that the rolls may get a hold on the steel. The power factor is another characteristic of the induction motor which merits careful consideration. Rolling mills, because of the employment of low-speed motors, the intermittent character of the load, and the construction of the motors, for mechanical reasons, with large air gaps, which involves a large magnetizing current, commonly have a low power factor; the recent systems of speed regulation for induction motors have been designed with the secondary purpose of improving the power factor by compensation of the phase difference.

The first of these systems was invented by Dr. A. Scherbius. Instead of being connected with a variable resistance, the slip rings of the induction motor are connected with a "regulating motor" of the three-phase commutator type, generally shunt excited and so wound that it possesses no inductance, hence for all practical purposes operating as a continuous-current machine. Its purpose is to convert the slip energy, formerly lost in resistance, into mechanical energy. "The speed regulation of the main induction motor is obtained in a simple manner by adjusting the excitation of the commutator motor. As is well known, the slip of an induction motor is proportional to the rotor voltage. When the rotor voltage is forced by exterior means to increase, the speed will have to decrease. For a strong excitation of the regulating motor the speed of the main motor will consequently be low, whereas for weak excitation it will be in the neighborhood of synchronism. As the armature voltage of the regulating motor, which

differs from the rotor voltage of the induction motor only to the extent of the ohmic drop in voltage, merely depends upon the excitation, the speed will remain constant from no load to full load. When a drop of speed is required between no load and full load, the regulating motor is provided with a compound exciting winding. As in the case of a continuous-current compound motor, the speed will then drop from no load to full load over a certain adjustable range. Finally, a series excitation can be provided, which entails a form of regulation similar to that by resistance."

The slip energy converted into mechanical energy by the regulating motor may be recovered in either of two ways: the energy may be given back to the main driving shaft by coupling the regulating motor mechanically with the main motor, usually the better arrangement; or the energy may be returned to the line by using the regulating motor to drive a small induction generator. In the first case the available energy in the main shaft remains constant—that is, the torque can be increased as the speed decreases; in the second case only a constant torque is available, so that the output must decrease with decreasing speed. In addition, the total efficiency of the first arrangement is superior to that of the second. It is not always possible, however, to employ the mechanical connection; in some cases the regulating motor, which with mechanical connection must follow the speed fluctuations of the main motor, becomes too expensive for very wide ranges of regulation.

A great advantage of the Scherbius system lies in the possibility of extending the regulation above synchronous speed; hence, the regulating motor can be built smaller than is possible with regulation solely under synchronism. In order to obtain over-synchronous speeds it is only necessary to reverse the direction of the excitation of the regulating motor. The latter then runs no longer as a motor but as a generator. The Scherbius system also permits of compensating the phase difference between current and voltage of the main motor, so that its power factor becomes unity, independently of the load. By a small change in design, the regulating motor can be made to supply the magnetizing current necessary for the excitation of the main motor, thus relieving the generators and the transmission line of the delivery of this wattless current. If necessary the regulating motor can also be designed to supply the excitation for other motors on the line, and thus will contribute still further to raise the power factor of the entire system. The Scherbius system may be applied either in new installations or to induction motors already installed.

A second system of economical induction-motor speed regulation is due to C. Krämer. "The slip rings of the main motor are connected to a rotary converter which changes the slip energy into continuous current. The latter is used to feed a continuous-current shunt motor, which is coupled mechanically to the induction motor and returns the slip energy to the main driving shaft. The speed is regulated by varying the resistance in the shunt field of the auxiliary motor. When resistance is cut out, the armature voltage, and the continuous-current voltage of the rotary converter, will increase. At the same time the alternating-current voltage at the slip rings must increase, as the continuous-current and alternating-current voltage of a rotary converter stand in a fixed relation to each other. The speed of the main motor will thus decrease."

The speed of the rotary converter depends upon the rotor frequency of the main motor, and is proportional to the regulation. As the voltage at the slip rings should also increase in proportion to the regulation, and as in general voltage and speed are proportional values, the design of the rotary converter is practically independent of the amount of speed reduction required. For this reason the Krämer system is very suitable for wide ranges of regulation. The available output remains constant over the entire range of regulation, as the slip energy is returned to the main driving shaft; the power factor of the main motor may be improved to unity by adjusting the excitation of the rotary converter accordingly. The disadvantages of the Krämer system in comparison

with the Scherbius system are its greater complication and the greater difficulty of applying it to existing installations.

For small outputs the single-phase commutator motor of the Déri type offers a third solution of the problem of economical speed regulation. This motor belongs to the repulsion-motor class. For each pair of poles the motor has four brush holders, two fixed and two movable, each set of fixed brushes being connected electrically with a set of movable brushes. At rest, both are in line on the commutator in the pole middle. When the movable brushes are shifted to the right, the motor turns to the left, and *vice versa;* hence, a reversal is possible without any switching over. The farther the movable brushes are shifted from the zero position, the more the torque increases. Normally the motor can start with two to two and one-half times the normal torque, and it may be designed for still higher starting torques. It also possesses a large overload capacity.

The great advantage of the Déri motor lies in its extreme simplicity; the entire regulation—starting, reversing, and adjusting of all speeds from zero to 10 per cent. above synchronism—is effected by merely shifting the brushes, and the only extra piece of apparatus required is a two-pole stator switch. When the output is small, the single-phase Déri motor will hardly affect the even distribution of the load on the three phases of the system, especially if there are several motors which can be divided among the different phases. For large outputs it is better to use a double commutator motor, which consists electrically of two Déri motors mechanically built into one. By a simple method of winding, the double motor can be directly connected to a three-phase line, and exact measurements have proved that with it the load is quite as equally distributed over the different phases as in the case of a normal induction motor, while the double motor retains all the good qualities of the simple Déri motor.

For the regulation of rolling-mill motors, both the Scherbius and the Krämer systems are in use. The Déri double motor gives excellent service in driving plate-bending machines, corrugated tube mills, and other small rolling mills of special type. For blowers the Scherbius system with regulating set is often very useful. Most of the auxiliary drives in steelworks, which require speed regulation, are well served by the single or double Déri motor, which is particularly adapted to the operation of live rollers, blast-furnace hoists, travelling cranes, and similar equipment.

THE RECONSTRUCTION OF THE QUEBEC BRIDGE.

A BRIEF DESCRIPTION OF THE METHODS OF REMOVING THE WRECK AND OF THE PLANS FOR THE NEW STRUCTURE.

Engineering Record.

PLANS for the reconstruction of the Quebec Bridge on the site of the ill-fated structure which collapsed during construction a little over three years ago have been completed, and work on the substructure is now in progress, while the contract for the fabrication and erection of the steel work is expected to be awarded very soon. As is well known, the rebuilding of the bridge was assumed by the Department of Railways and Canals of Canada, and a Board of Engineers, consisting of H. E. Vautelet, Maurice Fitzmaurice, and Ralph Modjeski, were appointed to supervise the design and construction. Publicity has not yet been given to the Board's detailed plans and specifications, but data of the general nature of the design, of the methods of removing the wrecked superstructure, and of the construction work now in progress are given in the *Engineering Record* of recent dates.

It will be remembered that the site of the bridge is about 8 miles above Quebec, where the St. Lawrence flows between steep sandstone banks about 3,500 feet apart and 200 feet above low water. The current at this point is very swift and the tide rises 12 to 16 feet. The channel is about 1,200 feet wide at low tide and 2,000 feet at high tide, the depth

increasing rapidly from low-water mark to 200 feet in mid-channel. To avoid the very deep water, the main piers of the original structure were located 1,800 feet apart on centers, their sites being in very shallow water at low tide, while the anchor piers were built on dry land. The superstructure was proportioned for a live load consisting of two E-33 locomotives and a train weighing 3,300 pounds per linear foot on each of the two tracks; for 60-ton electric cars on each of the two tracks; for two highways; and for two cantilever sidewalks. The material, carbon steel, was subjected in some members to high unit stresses.

"The superstructure, 2,800 feet long between anchorages, was symmetrical about the center and composed of a 675-foot center span suspended from two 562½-foot cantilever arms continuous across the river piers with the two 500-foot anchor arms. The pin-connected trusses were in vertical planes 67 feet apart, and were 315 feet deep at the main pier, and 130 feet deep at the center. Both top and bottom chords were parabolic curves and the panels were 50 feet long in the anchor arm and 56¼ feet long in the cantilever arms. The bottom chords had a rectangular section about 4½ feet deep and 5½ feet wide, made with four built channel webs connected by single angle lattice bars and tie plates on the top and bottom flanges and field spliced with rivetted cover plates. The maximum compression chord pieces were about 68 feet long, with a sectional area of 842 square feet and a weight of 100 tons. The total estimated weight of the superstructure was about 80,000,000 pounds. All pieces were wholly fabricated in the shop and shipped complete to the site." This was the structure which collapsed without warning on the morning of August 29, 1907, following the failure of the lower chord members in the south anchor arm.

The removal of the twisted mass of wreckage was begun in December of last year. The contract called for the removal of about 9,000 tons of material in the anchor arm and in the cantilever arm immediately adjacent to the main pier, the greater part of the cantilever arm lying in very deep water. The pile of wreckage was about 500 feet long, 70 to 80 feet wide, and 10 to 40 feet high. Considerably over half the material has been removed to date by the use of the oxy-acetylene torch and dynamite. A very interesting description of the methods employed is published in the *Engineering Record* for September 17. The use of dynamite is considered more economical than the torch; it is, however, more dangerous and cannot be used in all cases. The method of application is to attach a continuous row of sticks of 65 per cent. dynamite to the member on the line on which it is desired to cut and to explode the charge by means of a battery. It is found that about 1 pound of dynamite per 1,000 pounds of steel is required to break the members into 10-ton pieces within the capacity of the derricks. The rivets are removed by hand in the storage yard.

Turning now to the plans for the new structure, which are described in the *Engineering Record* for September 10, the new bridge, like the old one, "will carry two railroad tracks, two trolley tracks, two highways and two sidewalks on a single deck at about the same grade, but it is proportioned for heavier live loads and smaller unit stresses, thus effecting a large increase in the dead weight of the superstructure.

"Greater stability has been secured by increasing the width between trusses, which necessitates piers longer than those of the former design. Although the old piers were high-class structures, in perfect condition and uninjured by the disaster, it was not considered practicable to enlarge them to receive the new superstructure and it was determined to move the bridge axis 15 feet up stream and to build the north river pier alongside the old pier and clear of it, and to build the south river pier partly on the foundation of the old river pier, removing the old pier masonry in both cases down below low water level, and diminishing the length of the channel span 52 feet. The anchor piers are to be removed and new anchor piers, necessary in order to develop the required larger anchorage reaction, are to be built.

"The new superstructure has short deck approach spans at each end and

three main spans, with pin-connected trusses symmetrical about the center line. The channel span is 1,758 feet long on pier centers, with a maximum clearance of 159.3 feet above ordinary high tide in the center of the channel. The regular official design is for a superstructure 3,232 feet long over all with three short approach spans and three main spans 2,930 feet long between anchorages. The main spans have pin-connected nickel-steel through trusses 88 feet apart on centers, symmetrical about the center line, forming one 586-foot suspended center span, about 114 feet deep over all, two anchor arms, and two cantilever arms each 586 feet long and about 298 feet deep over the main piers and is adapted for cantilever erection of the suspended span.

"The most conspicuous features in which this design differs from that of the wrecked structure are the greater width of the structure, the straight line top and bottom chords, the system of web members, the uniform panel lengths, the greater lengths of the anchor arms and the shorter lengths of the suspended span in proportion to the distance between river piers, the heavier loads, smaller unit stresses, rock foundations and various structural details.

"The 8 by 10-foot rectangular bottom chord has a maximum sectional area of 2,037 square inches and is made with four vertical webs connected by top and bottom flange and intermediate lattice bars, by solid flange cover plates between the inside webs and by vertical transverse diaphragms. The depth is tapered from 8 feet at the main pier to 5 feet at the extremities of the anchor and cantilever arms. The top chord is made with two parallel tiers of eye-bars, one above the other. The floor beams have solid double webs 10 feet deep and riveted connections to facilitate erection. The trusses take bearing on the main piers with riveted pedestals 19 feet high which weigh 500 tons each. The heaviest bottom chord pieces weigh 160 tons each and have center longitudinal field splices. The main posts over the river piers weigh 900 tons each. The estimated weight of the entire superstructure is about 145,000,000 pounds.

"An alternative design has been prepared to permit the erection of the center span by floating to position and hoisting from the ends of the cantilever arms. This feature greatly reduces the erection stresses, diminishes by one year the time necessary for construction, and reduces the amount of steel required in the cantilever arms, thus effecting a corresponding decrease in the weight and stresses of the anchor arms and permitting their length to be economically reduced to 502 feet, corresponding with a total estimated weight of about 130,000,000 pounds for the superstructure between anchorages, and involving longer approaches.

"Nickel-steel eye-bars and bottom chord pieces have been tested to destruction to show the comparative efficiency of different methods of annealing and the ultimate strength of the compression members. The bottom chord pieces, made to ¼ scale, developed an ultimate unit strength of about 64,000 pounds and uniformly failed at the transverse diaphragms, all of the principal materials indicating substantially simultaneous failure by compression. When the webs were made with two plates spliced on a longitudinal line to avoid the difficulties of securing plates 96 inches wide for the full size chords, it was found that the strength was very greatly impaired.

"A comparison of the engineers' design with that of the double track, 1,710 feet span of the Forth Bridge shows for the Quebec Bridge: live load per linear foot, 13,340 pounds; total weight, 145,000,000 pounds; weight per linear foot of cantilever only, 49,150 pounds; weight of steel in structure for each pound of live load carried, 3.69 pounds. The corresponding values for the Forth Bridge are, respectively, 4,480 pounds, 114,000,000 pounds, 21,360 pounds, 4.77 pounds. The Quebec Bridge is designed for a load 2.98 times as great as the Forth Bridge, weight 2.3 times as much per linear foot, and is required to sustain a test load 4.33 times as heavy. The new Quebec Bridge is proportioned for a load about twice as great as that for the old Quebec Bridge but its bottom chords have an ultimate strength more than five times as strong, both values being computed from the results of experiments on test pieces."

THE HEAT TREATMENT OF BRASS.

AN INVESTIGATION OF THE EFFECT OF HEAT TREATMENT ON 70:30 BRASS, AND OF THE PHENOMENA OF BURNING.

G. D. Bengough and O. F. Hudson—Institute of Metals.

SOME valuable information on the effects of heat treatment on rolled and drawn 70:30 brass of varying sizes of section and somewhat varying character is contained in the record of a careful experimental investigation by G. D. Bengough and O. F. Hudson, whose paper read at the recent meeting of the Institute of Meals is printed in *Engineering* for September 23. The main object of the research was to throw some light on the phenomena of "burning." The definition of burnt brass given in the paper—brass of which the ductility, as measured by the percentage elongation, has been lowered by heat treatment—was slightly modified by Mr. Bengough in the discussion; he defined it finally as brass unusually susceptible to cracking, in which the susceptibility might be induced by annealing at a very high temperature, or by annealing at a lower, combined with simultaneous mechanical work. The "burning" of brass is a subject on which a good deal of research has been expended, but hitherto without very definite results. While the results of the present investigation are, in the main, negative, they serve to clear up some points of dispute, and place the discussion of others on a more scientific basis.

The experiments were made on test pieces cut from ¾-inch round bars representing the ordinary 70:30 brass of commerce. Three samples were used, of which the first and second (designated G and HB) were hard rolled, and the third (designated B) was in a softer state. The bars had the following percentage compositions:

Bar.	Cu.	Sn.	Pb.	Fe.
G	71.0	0.02	0.25	0.20
HB	69.4	trace	0.005	0.15
B	69.7	"	trace	0.20

It will be noted that bar HB was of unusual purity. "The bars as received from the makers were cut into 9-inch lengths, turned to a diameter of ½-inch for 4 inches in the centre of the bar, and heated in electrically heated tube furnaces, the temperatures of which were ascertained and controlled by thermo-electric pyrometers. After annealing, the bars were withdrawn at a dull red heat, cooled in air and tested in the ordinary way. Before testing, a piece was cut from each test bar for miscroscopic examination. With a view to ascertaining the influence of size of section, a hard-drawn wire of ⅛-inch diameter was annealed at the same time as the test bars. Test pieces of this bar were also heated in an electric resistance furnace to temperatures between 300 and 600 degrees C., and tested while at these temperatures. Various subsidiary sets of experiments were also made, particularly on the question of 'burnt brass'."

The results of these tests are given in a series of curves and tables. In all the tensile tests on bars and wire annealed for half an hour, "the maximum stress increases with rise in annealing temperature up to about 300 degrees C. It then falls off rapidly to 500 degrees C. The HB bar evidently had received more work than the G bar or the wire, and in consequence there is a much greater numerical loss of strength between these temperatures. Nevertheless, for temperatures between 500 degrees and 800 degrees C., the strength of the HB test bars is in all cases superior to that of the G bars, though the superiority gradually diminishes as the temperature rises, and has disappeared at 850 degrees C. As regards the wire, the strength falls off uniformly from 500 degrees to 900 degrees C., and is, for all temperatures, less than that even of the G bars, the difference increasing as the temperature rises. It will be seen later that prolonging the time of annealing has the effect of lowering the strength of a bar; it would also seem from the above that decreasing the section has a similar effect. The corollary at first sight would seem to be to proportion the time of annealing to the section of the bar, and so to avoid

burning thick sections by annealing at higher temperatures. It will be seen later, however, that time is at least as important a factor in burning as temperature. It does not seem, therefore, that any decided advantage can be claimed for the method suggested over the rival one of proportioning the temperature to the section. As a matter of fact, both plans are used in works.

Except in a very few cases, the yield points—the stresses required to give the first noticeable elongation—are not very sharply defined. The most interesting point established with regard to the effect of annealing temperatures on the yield point is the fact that annealing for one hour at a temperature of about 100 degrees C. has no effect on the yield point. Experiments to determine the effects of a period of rest and of very low annealing temperatures on the elastic limit demonstrated (1) that a prolonged period of rest raises the yield point; (2) that annealing for one hour at 90 degrees C. has no effect whatever; and (3) that annealing for one hour at 210 degrees C. very considerably lowers both elastic limit and yield point.

"In all cases the elongation is not much affected until an annealing temperature of 300 degrees C. is passed. Just above this temperature a very rapid increase occurs in the case of the wires. In the case of the bars the rapid increase sets in at about 350 degrees to 400 degrees C. Here, again, an increase in size of section seems to require a longer time of annealing to produce similar results. The maximum elongation is reached with an annealing temperature of 750 degrees C. for the wires, and with approximately the same temperature for the bars G. In both these cases a diminution seems to occur with annealing temperatures above 800 degrees C. For the HB bars, on the other hand, the elongation appears to increase regularly up to a temperature of 900 degrees C. In a general way the variations in contraction of area follow those in elongation. It may be remarked, however, that burning appears to manifest itself first by a falling off in the contraction of area."

The results summarized above were obtained in the tests on bars annealed for only half an hour. Further experiments were made to determine the effects of varying the annealing period; test bars were subjected to temperatures of from 750 to 900 degrees C. for periods of from 6 days to one week. The results show that the time of annealing has an even more important effect on the mechanical properties of brass than the temperature. A temperature but a few degrees below the solidus, if maintained for only half an hour, will not seriously burn a bar of pure brass. A temperature nearly 100 degrees lower will burn the brass if it is maintained for a sufficiently long time. Even small quantities of impurities have an important effect in increasing the tendency to burn.

To investigate the possibility that the presence of reducing gases in the annealing furnace might affect the mechanical properties of the brass, by causing a reduction of small amounts of oxide or slag contained in the metal, a number of bars were annealed in an atmosphere of coal gas. The results, which were practically the same as those obtained with an oxidizing atmosphere, show that the presence of reducing gases is, at any rate, not a predominant factor in the production of burnt brass. A theory of "burning" which has obtained some credence is that the effect is produced by loss of zinc by volitalization. This theory has been tested by estimating the copper in turnings taken at various depths from bars annealed at the higher temperatures. The loss of zinc is appreciable, but it is confined to a very short distance from the surface. Moreover, the zinc does not appear to be removed by violent ebullition, but by gentle diffusion and evaporation from the surface. It seems probable that the removal of zinc is not a primary cause, but merely an accompaniment, of burning. To a very limited extent it occurs also at ordinary annealing temperatures.

Tests were made on the mechanical properties of brass wire at high temperatures. It was found that the maximum stress falls off continuously. The elongation and contraction of area, on the other hand, falls off to very low values at temperatures between 300 and 400 degrees C., after which a recovery of

ductility occurs (between 450 and 475 degrees C.) which is practically maintained at 590 degrees C., the highest temperature employed. At the temperature of the ordinary annealing furnace (about 650 degrees C.) the mechanical properties of brass are, as is well known, such as to require rather careful handling. If the temperature of the annealing furnace were to rise somewhat higher than that usually employed, it is possible that the maximum stress might fall off to such a low figure as to be a source of serious difficulty whenever it becomes necessary to handle the alloy. It seems possible, too, that any handling of the material at even a slightly higher temperature than usual, though it may not actually fracture it, may cause a permanent deterioration of its properties.

STERILIZATION OF WATER BY ULTRA-VIOLET RAYS.

THE APPLICATION OF THE QUARTZ-TUBE, MERCURY-ARC LAMP TO THE STERILIZATION OF WATER ON A COMMERCIAL SCALE.

Max von Recklinghausen—Electrical Review; K. C. Grant—Engineering News.

DURING the last few months a vast amount of research work has been carried out in France on the bactericidal effect of ultra-violet rays and their application to the sterilization of liquids. Since the sterilizing action of ultra-violet rays was positively announced by Downes and Blunt in 1877, and particularly since Finsen's classical researches, the use of these rays in therapeutics has shown a steady increase. Further, it is now common knowledge that the ultra-violet rays of the sun play a most important part in the disinfection of water exposed to the sunlight, and are almost wholly responsible for the counteraction of bacterial pollution of rivers, such as is caused by the sewage of large cities, within a few miles of the source of pollution. The experiments now in progress, however, represent the first attempt to utilize the bactericidal properties of ultra-violet rays on any considerable scale.

The reason for the long period of neglect of this sterilizing medium is to be found in the lack of a satisfactory light source previous to the invention of the quartz-tube, mercury-arc lamp. The amount of ultra-violet rays which reach the earth from the sun is very small, and some artificial source has to be employed. The development of artificial sources for the production of ultra-violet rays is sketched briefly by Max von Recklinghausen in *The Electrical Review*, for September 2. The well known carbon-bisulphide lamp was the first reliable source. Later, Finsen and his collaborators worked out the arc and spark lamp with metal electrodes. The next lamp to produce a large quantity of ultra-violet rays was the Cooper Hewitt mercury arc, but in the lamp sold for general illumination, the ultra-violet light is not apparent on account of the absorbent properties of the glass used. A large proportion of the ultra-violet rays are transmitted by the "Uviol" glass of Schott and Genossen; the glass *par excellence* for ultra-violet light sources, however, is that produced from molten quartz, and the modern quartz-tube, mercury-arc lamp, although its important application to sterilization was for a time unrecognized, is the basis of all modern research.

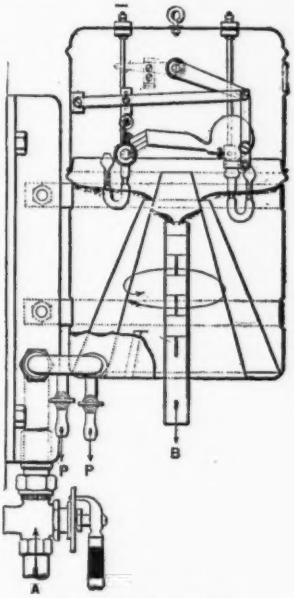
The most important of the investigations to which reference has been made is that in progress at the physiological laboratory of the Sorbonne in Paris, a brief description of which is contributed by Kenneth C. Grant to *Engineering News* for September 15. The object of the Sorbonne experiments is to perfect a practical application of the sterilizing action of ultra-violet rays to the purification of polluted water for public water supplies. The process used consists, in brief, in exposing the water to the ultra-violet rays from a quartz-tube, mercury-arc lamp suspended above and close to the surface of the liquid; the micro-organisms therein are killed by the direct action of the ultra-violet rays, without the evaporation of the dissolved gases, the precipitation of the soluble salts, or the formation of ozone or

oxygenated water, either of which might alter the taste and composition.

The experiments are made with very simple apparatus. A tank is filled with water from the Paris supply, which is then innoculated with about 5,000 bacteria per cubic centimetre. The water, raised from the tank by a small electric pump, is metered into a serpentine trough, through which it flows and from which it is metered back into the tank. The water passes under four lamps placed over the tortuous part of the trough, the rate of flow being regulated by the speed of the pump. Mr. Grant gives some data of the results obtained. A diagram based on the study of samples taken when the water was flowing at the rate of 1,270 cubic feet per hour, with two lamps in use, shows that after passing the first lamp the bacteria were reduced to about 3,800 per cubic centimetre, and were entirely destroyed by the second lamp. Each of the lamps required 660 watts per hour; hence the sterilization was at the rate of 960 cubic feet per kilowatt hour. With electricity at one cent per kilowatt-hour, therefore, the cost of energy is about $1.40 per 1,000,000 gallons.

"These experiments have successfully demonstrated the commercial possibility of purifying water in large quantities by this process. They are being continued in the attempt to increase the efficiency; this is being done by passing the water through a specially constructed chamber or valve in the trough, by means of which it is three times exposed to the rays of the same lamp. The clearness of the water used is an important factor in obtaining high efficiency. A turbid water, offering resistance to the passage of the ultra-violet rays must pass the light with a less depth and a lower velocity. In any installation for a large supply, therefore, it will be necessary in many cases to include in the scheme a suitable type of filter for prefiltration purposes, at times when the water is turbid.

"The first attempt to put this method of purification into practice is at Marseilles, France, where an experimental plant is being operated in competition with several other types of filtration and purification work." The capacity of this plant is reported to be 3,500 cubic feet per hour, sufficient for a town of about 10,000 inhabitants. The apparatus used is similar in principle to the small sterilizer for hospital use, a diagram of which is taken from Max von Recklinghausen's paper in *The Electrical Review*. In this



SECTION OF STERILIZER.

apparatus 132 gallons of sterilized water per hour is produced from ordinary city water by means of one Cooper Hewitt "Silica" lamp, consuming 3 amperes at 110 volts. The inlet pipe is fitted with an adjustible valve of a special pattern, to enable the apparatus to deal with the various water pressures met with in different districts. "The water enters the chamber formed by the outer cone with a swirling motion. At the top of this cone it overflows and finds an outlet at the bottom of the inner cone, up which it rises and flows out of the discharge pipe at B. The swirling motion is maintained during the complete passage of the water through the apparatus, in order that it may be thoroughly stirred up and all microbes presented to the action of the light, the water coming under its influence on two distinct occasions. Drain

cocks P are provided on the apparatus, to enable it to be thoroughly drained, should circumstances arise whereby it would not be used for a considerable time."

The lamp used in the Sorbonne experiments is of the same curious shape as that shown in the diagram. The U-tube at each end has a platinum seal at the contracted portions, and the portion between the seal and the end of the U-tube is filled with mercury, to insure absolute air-tightness of the seal. Above the seals sufficient mercury is contained to fill both ends just to the level of the bottom of the inclined portion of the tube. To light the lamp, the current is switched on and the tube is raised slightly at the positive or bulb end by means of a starting handle and suitable connecting levers. The mercury in the bulb runs down to the other end and a short circuit is made. When the tube is thrown back into its original position, the mercury stream is broken, an arc is sprung, and the tube becomes highly luminous.

PYRITE SMELTING AND SULPHURIC ACID MANUFACTURE.

AN EXAMINATION OF THE TECHNICAL AND ECONOMIC FACTORS IN THE RECOVERY OF SULPHURIC ACID AS A BY-PRODUCT IN COPPER SMELTING.

F. J. Falding and J. Parke Channing—Engineering and Mining Journal.

ON two previous occasions within the last two years* we have referred in these columns to the recovery of sulphuric acid as a by-product in copper smelting. Both reviews were descriptive of the methods employed by the two principal copper companies operating in Tennessee. We return to the subject to present, in abstract, a very lucid exposition of the technical and economic factors involved in the problem of pyrite smelting for acid recovery, contributed by F. J. Falding and J. Parke Channing to the *Engineering and Mining Journal* for September 17.

Pyrite smelting is a method of matte-smelting sulphide ores having iron as a base, which involves the utilization as completely as practicable, as fuel for the smelting process, of that part of the sulphur contained in the ore which is driven off as a gas in the preliminary operations of roasting or desulphurizing, as practised in ordinary blast-furnace smelting. Only sufficient coke is added to the blast-furnace charge to supply the heat for the smelting process which the natural fuel in the ore is unable to supply.

"In pyrite smelting, whether with or without coke, the constitution of the gases produced (apart from irregularities in the functioning of the furnace) will depend in the first place entirely upon the air admitted at the tuyeres. If only sufficient air is admitted at the tuyeres to provide oxygen for the oxidizing functions of the furnace, including such constituents of the charge as after oxidation pass out as furnace gases, then, if no coke is used, these exit gases will consist entirely of sulphur dioxide and nitrogen (together with flue dust and fume); or if coke is used, then the gases will consist of sulphur dioxide, carbon dioxide and nitrogen. In neither case would the resulting gases be suitable for making sulphuric acid, as there would be no oxygen for the conversion of the sulphur dioxide to the trioxide (SO_2 to SO_3) nor would there be the technically necessary excess of oxygen.

"If any excess of air is admitted at the tuyeres, there will be a corresponding excess of free oxygen in the resulting gas, whether smelting with or without coke. This excess can be so regulated that the resultant gases will have the proper composition as well as sufficient free oxygen for sulphuric-acid purposes, provided: (1) that the carbon or coke in the charge is not in such excess that to admit sufficient air to provide the necessary free oxygen for the sulphuric-acid process, would dilute the resulting gas below 4 to 5 per cent. SO_2, or below a practical strength for making sulphuric acid; and (2) that such admission of extra air at the tuyeres would not interfere with the smelting operation. If such admission of air in excess at the

* THE ENGINEERING MAGAZINE, February, 1909, and July, 1910.

tuyeres would interfere with the smelting process, then in both cases (with or without coke) additional oxygen would have to be added to the gas at some place between the top of the furnace burden (or the issuing point of the gas from the charge) and the apparatus where the further oxidation takes place; or the excess of air may be admitted into the apparatus itself.

"If it were possible to maintain an exact and constant equilibrium between the oxygen supplied at the tuyeres and the oxidizable contents of the charge, then a gas of uniform composition would result. For many reasons this is technically an impossibility, and consequently the gas issuing from the furnace is irregular and fluctuating. Sometimes the free oxygen is excessive, sometimes it is normal, and more often it is deficient or entirely wanting (as evidenced by the volatilization of sulphur and presence of CO).

"If the necessary quantity of oxygen were to be supplied at the tuyeres, then the volume admitted would have to be mechanically regulated in conformity with the analysis of the issuing gas. With the volume and pressure of the air remaining constant, the issuing gas must necessarily fluctuate as long as the charging of the furnaces is intermittent, for the furnace burden just after charging will contain more sulphur, iron and coke than it does just before charging.

"If the regulation of the supply of oxygen is to be provided above the charge, this can be accomplished, either by increasing the draft which is used to carry away the gas and thus induce the admission of air through openings provided in the top of the furnace; or the contrary, by decreasing the draft to reduce the admission of air through these openings; or otherwise by taking all precautions against the admission of false air by providing air-tight furnace tops so that the gas will not be diluted and the draft remain constant, when any deficency of oxygen can be supplied by mechanical contrivances such as fans, blowing engines, etc., which can deliver a controlled volume of air.

"If the furnace be provided with a second set of tuyeres above the smelting zone, the necessary excess of air might be provided without interfering with the smelting zone and in such a way as to secure the complete combustion of the sulphur which is partly driven off in the upper part of the furnace burden, and also to prevent the formation of crusts and bridges in the burden and probably also the more rapid formation of a higher-grade matte.

"More careful attention to the method of charging the furnace in pyrite smelting will produce better metallurgical results as well as a more constant gas. Such considerations would be: (1) an approximate sizing of the constituents of the charge; (2) the more thorough admixture of the charge; (3) the greater regularity in the distribution of the charge, and in the time of charging, smaller and more frequent changes being used—or some method of continuous charging.

"From the above it is evident that to make the gas from pyrite smelting suitable for sulphuric-acid purposes two points are vital: (1) that there shall be no coke in excess of a percentage on the sulphur content of the charge, which maximum percentage can be calculated for any given charge, and (2) that the furnace from the tuyeres up to the point where the gases are taken to the acid plant, must be so designed that a controlled quantity of air in excess of that required for the matte-smelting process can be admitted (a) at the tuyeres, or (b) between the tuyeres and the top of the furnace burden, or (c) between the top of the furnace burden and such points in the acid plant up to where the sulphur dioxide is completely oxidized, or (d) in part at any of these points. All admission of false air must be prevented as far as possible."

To illustrate the calorific power of iron and sulphur, the authors give four numerical examples of the calculation of the coke required for smelting pyrite or pyrrhotite ore charges containing various percentages of iron and sulphur. These data are used later to illustrate the method of calculating the quantity of air required and the composition of the resulting gas in each case. A chart shows for furnace charges containing 20,

30 and 40 per cent. of iron the relation between the sulphur content, above that required for matte, and the percentage of coke required for the smelting process and the percentage of SO_2 in the gas.

So far the discussion has considered the use of only one furnace. It is doubtful whether the gas from a single furnace can be used economically for the production of sulphuric acid. By observing the precautions mentioned above and by exercising great care in the management of the furnace, a reasonably uniform gas can be produced; a shut-down of the furnace for any reason, however, causes an undesirable interruption in the operation of the acid plant. The case is different when there are a plurality of furnaces. "In this case the furnaces must be provided with gas outlets discharging both into the main flue from which gas is taken to the sulphuric-acid plant and also into a by-pass flue connecting with the stack or discharge into the air. Both these exits must be provided with well fitting valves or dampers easily operated. Then it will be possible to cut out any furnace which is dead or for any other reason is not producing a suitable gas, and connect it direct to the stack. The other furnaces, discharging into a common flue, dust chamber or other reservoir from which gas is taken to the acid plant, will then produce an average gas which is much more likely to remain constant in its composition than the gas from any single furnace."

The principal requirement in sulphuric-acid making is a constant supply of gas of uniform composition. When the sulphur dioxide and oxygen contents of the gas fluctuate unduly, the regulation of the reagents with which it has to be met in the acid plant—nitrous oxide and water vapor—becomes exceedingly difficult. The fundamental requisites for successful by-product acid making are: (1) furnaces and appurtenances carefully built or remodeled for the production of a suitable and regular gas; (2) reasonable care in operation as to charge, blast at the tuyeres, and draft; and (3) a completely harmonious understanding of the required conditions between smelter manager and acid-plant manager. The utilization of the gas from pyrite smelting in the manufacture of sulphuric acid, after the necessary changes have been made to the plant, involves nothing but reasonable care on the part of the smelter manager.

It is a mistake to assume that since, in pyrite smelting, the sulphur, which is the principal item of cost in sulphuric-acid making, costs nothing, large quantities of acid can be made and profitably transported to any distance. The cost of changes to the smelter plant and the additional cost of manufacture entailed by the fluctuations in composition of the gas must be taken into consideration as additional process costs to the disadvantage of the by-product plant and in favor of the regular chemical manufacturer. In many cases the regular manufacturer receives about 70 cents per ton of 60 degrees B. acid from the sale of pyrite clinker as an iron ore. The cost of Spanish pyrites at central inland points in the United States, according to whether the clinker is sold or not, may be said to vary between $3 and $4 per ton of 60 degrees B. acid at inland cities. Some of these cities secure some of their pyrites locally. St. Louis has local pyrites mines, and Chicago draws a certain amount of her supply from the marcasite which occurs in the Wisconsin zinc ores. In fact, the by-product gases from the zinc smelters will always control the acid production of the Middle West. It is evident, therefore, that the profitable exploitation of the by-product gases at any given smelter will be limited: (1) by a freight rate to point of consumption of from below $3 minimum to $4 maximum per ton of 60 degrees B. acid; and (2) by the sale of such by-product acid in a territory which cannot be entered more profitably by any other smelter manufacturing sulphuric acid. It is a curious fact that while zinc ores are profitably brought east from Colorado for smelting and the production of by-product acid, a smelter in Colorado could hardly compete as an acid maker with a smelter in Illinois, because of the difference between the freight rates on ore and acid, and the necessity of shipping acid in tank cars, which have to be returned empty, and the maintenance and amortization of which must be charged against the acid.

THE ENGINEERING INDEX

"THE KEYSTONE IN·THE·ARCH·OF·APPLIED·SCIENCE"

The following pages form a *descriptive* index to the leading and special articles of permanent value published currently in the Transactions of all the important engineering societies of both Europe and America, and in all the leading engineering journals of the world—in the English, French, German, Dutch, Italian, and Spanish languages.

The term *descriptive* is used because the definite purpose of each index note is to indicate clearly the character and purpose of the article or paper described; and with that in view we give the following essential information about every publication:

(1) The title of the article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the article itself, if desired.*

☞ The full text of every article described in the Index, together with all its illustrations, can usually be supplied by us.—See the "Explanatory Note" at the end of the Index, where also the full titles of the principal journals indexed are given.

NOTE—The busy engineer will also observe that the Index is conveniently classified into the larger divisions of engineering science, to the end that the reader may quickly turn to what concerns himself and his special branches of work. By this means it is possible, within a few minutes' time each month, to learn promptly of every important article published anywhere in the world, in any language, upon the subjects claiming one's special interest.

DIVISIONS OF THE ENGINEERING INDEX.

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CIVIL ENGINEERING.

BRIDGES.

Arches.

The Arch Principle in Engineering and Esthetic Aspects, and Its Application to Long Spans. C. R. Grimm. Presents some suggestive designs for a bridge of several spans, carrying railroad and street traffic across a wide river, the channel span to be of the greatest length thus far used in practice. Ills. 6000 w. Pro Am Soc of Civ Engrs—Sept., 1910. No. 17556 F.

Three-Hinged Arch Vaulting Over the Saint Martin Canal, Paris. Illustrations and notes from articles by M. Mesnager, in *Le Génie Civil*, indicating the character of the work and the methods employed. 1200 w. Eng Rec—Sept. 10, 1910. No. 17047.

Bascule.

The Eight-Track Bascule Bridge at Campbell Avenue, Chicago. C. R. Dart and S. T. Smetters. Illustrated detailed description of an interesting structure.

We supply copies of these articles. See page 327.

General discussion. 6000 w. Jour W Soc of Engrs—Aug., 1910. No. 17333 D.

Concrete.

The Construction Methods on the Rocky River Bridge, with Some Costs. Sectional plans and elevations, with description of methods employed in building a bridge with a 280-ft. concrete arch span. 6500 w. Engng-Con—Sept. 14, 1910. No. 17118.

Design.

Construction of Certain Curves Applicable in the Design of Bridges (Sur le Tracé pratique de certaines Courbes transcendantes utilisables dans la Construction des Ponts). Maurice d'Ocagne. Describes a method for catenary curves, applicable also to any curve with an axis of symmetry. Ills. 4500 w. Ann d Ponts et Chaussées—1910-IV. No. 17207 E + F.

Floors.

See Masonry, under BRIDGES.

Foundations.

See Quebec, under BRIDGES.

Masonry.

Improving a Granite Viaduct—Boston & Providence Railroad. Illustrates and describes a viaduct across the Neponset River, and the method of reinforcement without interrupting traffic. 900 w. Eng Rec—Sept. 10, 1910. No. 17051.

A New Bridge at Toulouse. Illustrations and brief description of a remarkable bridge across the Garonne River, having two parallel masonry arches connected by a floor of reinforced concrete. 300 w. Sci Am—Sept. 10, 1910. No. 17018.

Experiences in the Construction of the 85-Metre Masonry Arch Over the Isonzo at Salcano (Erfahrungen und Beobachtungen beim Bau der 85*m.* weiten Wölbbrücke über den Isonzo bei Salcano). Leopold Oerley. Gives interesting data of the design and construction. Ills. Serial. 1st part. 3000 w. Zeitschr d Oest Ing u Arch Ver—Aug. 19, 1910. No. 17464 D.

Quebec.

Removal of Wrecked Superstructure, Quebec Bridge. Describes the condition of the wrecked spans, and the methods of removal adopted. 1600 w. Eng Rec—Sept. 17, 1910. No. 17153.

The Reconstruction of the Quebec Bridge. Explains the general conditions, describing the original structure, its erection and collapse, and the general design of the new structure. Ills. 2000 w. Eng Rec—Sept. 10, 1910. No. 17044.

The Plant for Constructing the Quebec Bridge Substructures. Information concerning the reconstruction, illustrating and describing the costly contractor's plant for carrying on the work. 2500 w. Eng Rec—Sept. 24, 1910. No. 17402.

Caissons for the Main Piers of the New Quebec Bridge; Launch of the North Pier Caisson. Illustrates and describes the substructure work for the new Quebec Bridge. 1500 w. Eng News—Sept. 8, 1910. No. 17005.

Caissons for the Main Piers of the New Quebec Bridge. Illustrates and describes the work in progress and methods employed. Plate. 1200 w. Engr, Lond—Sept. 2, 1910. No. 17096 A.

Reinforced Concrete.

Notes on the Construction of a Reinforced Concrete Arch Bridge, with Some Costs. W. A. Hoyt. The work described is a highway bridge of seven 80-ft. spans. Ills. 2500 w. Engng-Con—Sept. 7, 1910. No. 17025.

The Amélie-les-Bains Three-Hinged Reinforced-Concrete Arch (Pont en Béton armé, à trois Articulations, d'Amélie-les-Bains, Pyrénées-Orientales, et Applications du même Systéme de Semi-Articulations). M. Mesnager. Brief description with plate. Ills. 2500 w. Génie Civil—Aug. 27, 1910. No. 17238 D.

Steel.

Typical Compression Members in Long Span Bridges. Edgar Marburg. Gives data for comparison, relating to eight bridges. Ills. Plate. 3000 w. Eng Rec—Sept. 3, 1910. No. 16901.

Standard I-Beam Railroad Bridges Over City Streets. Illustrates and describes details of floor construction, waterproofing and expansion joint in the short span bridges of the N. Y. C. & H. R. railroad, carrying tracks over city streets. 1200 w. Eng Rec—Sept. 17, 1910. No. 17152.

The Erection of the Broad River Bridge. Describes work in North Carolina, on a single-track bridge. 1360-ft. long, and 160-ft. above water, carrying the C., C., & O. Ry. over the Broad River. Plate-Girder spans on steel towers, and a 200-ft. pin-connected deck channel span. Ills. 1600 w. Eng Rec—Sept. 17, 1910. No. 17159.

See also Testing, under BRIDGES.

Swing Bridges.

The Design of Swing-Bridges. James Athersmith Orrell. Describes types and calculates stresses. Ills. 11800 w. Inst of Civ Engrs—Students' paper, No. 636. No. 17369 N.

Testing.

Statical Tests of a Steel Bridge Over the Tanarus (Sulle Prove statiche del Ponte in Acciaio sul Tanaro). Gustavo Colonnetti. Describes the structure and the method of testing and gives results. Ills. 4500 w. Ing Ferro—Aug. 16, 1910. No. 17248 D.

Trestles.

Strengthening Old Trestles on the Wabash Railroad. Illustrates and describes the use of concrete to preserve the metal in an old trestle, and to increase the strength of the structure. 1500 w. Ry. Age Gaz—Sept. 9, 1910. No. 17015

We supply copies of these articles. See page 327.

Viaducts.

An Armored Concrete Viaduct at Rotterdam. Illustrated description of the structure and the methods of construction and reinforcement. 3500 w. Engr, Lond—Sept. 9, 1910. No. 17310 A.

CONSTRUCTION.

Bins.

Cement Storage Plant of the Croatia Portland Cement Company in Podsused near Agram (Siloanlagen der Portland-Zement-Fabrik "Croatia" A.-G. in Podsused bei Agram). S. Zipkes. A detailed description of an extensive plant. Ills. Serial. 1st part. 1000 w. Deutscher Bau—Aug. 31, 1910. No. 17294 B.

Caissons.

See Quebec, under BRIDGES.

Coaling Stations.

Two Concrete Locomotive Coaling Stations. W. E. Witte. Illustrates and describes recently built stations at Nicetown, Pa., and at Philadelphia. 3000 w. Eng Rec—Sept. 3, 1910. No. 16908.

Concrete.

Notes on Drilling Holes in Concrete. J. R. Taft. Gives data and cost. 700 w. Eng Rec—Sept. 3, 1910. No. 16906.

Exterior Treatment of Concrete Surfaces: Committee Report to the National Association of Cement Users. The completed report, somewhat condensed and abstracted. 6500 w. Eng News—Sept. 15, 1910. No. 17111.

Methods of Employing Concrete in Marine Structures with Data on Durability of Concrete in Sea Water and Examples of Typical Marine Structures of Concrete. Chandler Davis. Abstract of a paper read at Convention of Nat. Assn. of Cement Users. Ills. 4000 w. Engng-Con—Aug. 31, 1910. No. 16856.

Concrete Construction in Manila and the Philippine Islands. W. C. Reibling. A discussion of the materials used and the importance of investigating carefully and developing standard methods of testing. 4 plates. 6000 w. Philippine Jour of Sci—March, 1910. No. 16937 N.

Contractors' Plants.

See Quebec, under BRIDGES.

Cost Keeping.

Cost-Keeping in the U. S. Reclamation Service. D. W. Murphy. An explanation of the methods employed. 3000 w. Eng News—Sept. 8, 1910. No. 17002.

Engineers' Cost-Keeping System, New York State Barge Canal. An explanation of the system worked out, which has proved very satisfactory. 1000 w. Engng-Con—Sept. 7, 1910. No. 17026.

Demolition.

Demolition of the Side Wall of the Passage Between the Saint Nazaire Dry Docks (Démolition en Ventouse d'un Parement du Bajoyer du Pertuis de Communication entre les Bassins du Port de Saint Nazaire). M. le Trocquer. Describes work preliminary to an enlargement of the passage made necessary by the increased size of recent cruisers. Ills. 8000 w. Ann de Ponts et Chaussées—1910-IV. No. 17208 E + F.

Earth Subsidence.

Progressive Subsidence Near Main St., Cambridge, Mass., and the Design of the Main Street Subway. Frank H. Carter. An interesting account of slow subsidence and its effects on engineering structures. Map and profile. 3000 w. Eng News—Sept. 8, 1910. No. 17000.

Excavation.

Precautions for Maximum Safety and Effectiveness in Blasting. An illustrated discussion of the electric firing system and the general precautions for safe and effective work. 5000 w. Eng News—Sept. 22, 1910. No. 17353.

See also Ore Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Failures.

See Reservoirs, under WATER SUPPLY.

Piling.

Method of Jetting Down Concrete Piles and Records of Output. Data relating to the making and sinking of about 200 reinforced-concrete piles, at Atlantic City. Ills. 1600 w. Engng-Con—Sept. 14, 1910. No. 17119.

Reclamation.

The Reclamation of Low Lands Near Stockton, California. Describes the character of the country and methods of reclamation work. Ills. 1600 w. Eng Rec—Sept. 5, 1910. No. 16904.

The Drainage of the Mississippi Delta. Arthur E. Morgan. Explains conditions in the Delta, and the work that has been done and proposed. Ills. 2000 w. Mfrs' Rec—Sept. 8, 1910. Serial. 1st part. No. 16979.

Reinforced Concrete.

The Economy of Reinforced Concrete Construction (Zur Frage der Wirtschaftlichkeit des Eisenbetonbaues). Fr. Baumann. Examines the relative merits of steel and reinforced concrete for large structures. 2800 w. Stahl u Eisen—Aug. 24, 1910. No. 17265 D.

The Calculation of the Deflection of Reinforced-Concrete Beams (Die Berechnung der Durchbiegung von Eisenbetonbalken). G. Kaufmann. Mathematical. 3000 w. Beton u Eisen—Aug. 2, 1910. No. 17471 F.

Pioneer Reinforced Concrete Work. Carlton Strong. An illustrated account of the construction of the Alabama, afterwards known as the Berkley Hotel, erected at Buffalo, N. Y., 1894. 5500 w. Cement Age—Sept., 1910. No. 17326.

A Reinforced Concrete Warehouse at Lowell, Massachusetts. Illustrated detailed description of a structure to be

erected in the center of the business section of the city by the Mass. Cotton Mills Co. 1200 w. Cement Age—Sept., 1910. No. 17327.

See also Coaling Stations, Roofs, Stacks, and Steel, under CONSTRUCTION; Reservoirs, and Water Towers, under WATER SUPPLY; Docks, and Wharves, under WATERWAYS AND HARBORS; and Stations, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Retaining Walls.

Fifth Avenue Retaining Wall; Oregon & Washington, Seattle, Wash. Illustrates and describes details of a wall varying in height from 0 to 45 ft. with a total length of 1,680 ft. 400 w. Ry Age Gaz—Sept. 16, 1910. No. 17135.

Roofs.

The Gisshammer Reinforced-Concrete Roof (Universal-Betondecke "System Gisshammer"). Richard Hoffmann. Brief description of the system. Ills. 2000 w. Beton u Eisen—Aug. 2, 1910. No. 17470 F.

Stacks.

Reinforced Concrete for Chimney Construction. P. S. Sheardown. Notes on the reinforced-concrete lining of the steel chimney shafts at Ringsend station of the Dublin United Tramways Co., and on chimney construction of this material. Read at the Dublin Cong. of the Tram. & Lgt. Ry. Assn. 1500 w. Elect'n, Lond—Sept. 16, 1910. No. 17435 A.

Steel.

The Application of Steel in Building Construction (Die Verwendung von Eisen im Hochbau). A criticism, defending reinforced concrete, of Herr Fischmann's paper on this subject in *Stahl und Eisen* for May 11, 1910, with reply by Herr Fischmann. 6500 w. Stahl u Eisen—Aug. 24, 1910. No. 17266 D.

Formulas for Use in Detailing Steel Structures. Hart Vance. Aims to make available formulae developed in spherical trigonometry applicable to hoppers and various forms of towers with inclined columns or "legs." Ills. 2000 w. Eng News—Sept. 1, 1910. No. 16846.

A Steel and Reinforced Concrete Grand Stand. Illustrated detailed description of a structure in Chicago. 1500 w. Eng Rec—Sept. 3, 1910. No. 16902.

Steel Substructure, Pennsylvania Terminal Post Office. Illustrates and describes the steel-work for this new U. S. Post-Office building in New York City, which will occupy nearly all of two city blocks, and cost about $4,000,000. 2500 w. Eng Rec—Sept. 10, 1910. No. 17053.

Structural Steel Details in the Wick Building, Youngstown. Illustrates and describes details of a steel-cage building 12 stories high with grillage footings on concrete piers about 12 ft. below curb. 2000 w. Eng Rec—Sept. 24, 1910. No. 17404.

Construction of the Whitehall Building Extension. Detailed description of the addition of a 32-story extension to a 20-story building in New York City. 2200 w. Eng Rec—Sept. 3, 1910. No. 16910.

See also Steel Works, under MINING AND METALLURGY, IRON AND STEEL.

Tunnel Lining.

Concrete Lining of the Rondout Pressure Terminal. An illustrated account of the methods and equipment employed. 5000 w. Eng Rec—Sept. 17, 1910. No. 17151.

Tunnels.

The Elizabeth Tunnel. W. C. Aston. Describes methods by which the highest American hard rock tunnel record was made. Ills. 2800 w. Mines & Min—Sept., 1910. No. 16881 C.

See also Pipe Tunnels, under WATER SUPPLY.

Underpinning.

Underpinning a Factory Building. F. E. Davidson. Reviews the conditions and resulting effects on a building in Chicago, which made it necessary to construct an entirely new foundation after the building was occupied. Describes methods. Ills. 5000 w. Jour W Soc of Engrs—Aug., 1910. No. 17331 D.

A Novel Method of Jacking Caisson Piles for Underpinning. Brief illustrated description of method of underpinning the Astor Building, 16 Wall St., N. Y., by using weight of adjoining building. 600 w. Eng News—Sept. 15, 1910. No. 17109.

MATERIALS OF CONSTRUCTION.

Concrete.

See also same title, under CONSTRUCTION.

Steel Corrosion.

Rust, as Shown in the Removal of a Seventeen-Story Building. T. Kennard Thomson. Brief report of the condition of the steelwork in Gillender Building, New York City. 350 w. Pro Am Soc of Civ Engrs—Sept., 1910. No. 17557 F.

Timber.

The Strength of Fir and Pine Timber (Die Festigkeit von Fichten- und Kiefernholz). Karl Dörr. Reviews the results of various tests since 1873. 2000 w. Deutsche Bau—Aug. 17, 1910. No. 17293 B.

MEASUREMENT.

Leveling.

The Leveling Operations of the United States Government. E. M. Douglas. A brief account of the spirit leveling carried out by various government departments. Ills. 2000 w. Eng News—Sept. 15, 1910. No. 17112.

Road Resistance.

See Accelerometer, under MECHANICAL ENGINEERING, MEASUREMENT.

Surveying.

The "Interval" Method of Determining Elevations in Stadia Surveys. Adolph

We supply copies of these articles. See page 327.

F. Meyer. A discussion of the advantages of this method. 1500 w. Eng News —Sept. 1, 1910. No. 16849.

MUNICIPAL.

City Planning.

Methods of Laying Out Cities. Charles W. Barnaby. Suggested improvements for safety and transport. 3500 w. Cassier's Mag—Sept., 1910. No. 17162 B.

City Design and Transportation. M. Wattman. Abstract of a report at the Brussels meeting of the Int. St. & Int. Ry. Assn. Considers the rapid growth of cities and the importance of transportation facilities; modern ideas of city planning, etc. Ills. 2000 w. Elec Ry Jour —Oct. 1, 1910. No. 17579.

Comfort Stations.

Riverside Shelter and Comfort Station. Illustrated detailed description of a structure of Doric architecture designed with special view to the requirements of the location, near Grant's Tomb, New York. 2500 w. Munic Jour & Engr—Sept. 28, 1910. No. 17519.

Drainage.

The Drainage of the Blato-Polje on Curzola Island (Die Entwässerung des Blato-Polje auf der Insel Curzola). Josef Horowitz. Discusses a project for draining a marsh to get rid of malaria-carrying insects. Ills. 2200 w. Oest Wochenschr f d Oeffent Baudienst—Aug. 6, 1910. No. 17466 D.

Mosquitoes.

The Modern Mosquito Extermination Campaign. John B. Smith. Illustrated description of the extensive work undertaken by the state of New Jersey. 2500 w. Eng News—Sept. 1, 1910. No. 16850.

Pavements.

A Study Into the High Cost of Asphalt Pavement Repairs in Chicago in 1908-9. Abstract of a report by S. Whinery to the Chicago Commission on City Expenditures. 7000 w. Engng-Con—Sept. 21, 1910. No. 17350.

See also Roads, under MUNICIPAL.

Public Health.

Annual Convention of the American Public Health Association. A report of the 38th annual meeting at Milwaukee, Wis., with abstracts of papers read. 6000 w. Eng News—Sept. 15, 1910. No. 17110.

Refuse Disposal.

Modern Practice in Garbage Disposal. Rudolph Hering, before the Am. Pub. Health Assn. Remarks on the Milwaukee incinerator, and a discussion of the best methods now in use for the disposal of city refuse. 3500 w. Eng Rec—Sept. 24, 1910. No. 17405.

Garbage Incinerators for San Francisco. Gives description and specifications of plant and reports a study made of the composition of the refuse. 4500 w. Munic Jour and Engr—Sept. 7, 1910. No. 16983.

Roads.

The Second International Road Congress. A review of the proceedings and the questions submitted. 3500 w. Engng—Aug. 26, 1910. Serial. 1st part. No. 16965 A.

The Second International Road Congress. E. L. Corthell. Information in reference to interesting features of the Congress. Also Final Conclusions adopted at Brussels. 5000 w. Eng News—Sept. 1, 1910. No. 16847.

The Kentish Ragstone Quarries. P. Walton Harrison. Read before the Inst. of Munic. Engrs. Describes the composition of this material and its use as a road stone, and for architectural and engineering works. 2000 w. Archt, Lond—Sept. 2, 1910. No. 17072 A.

Road Making in the United States. Vernon M. Peirce. Read at the Brussels Road Cong. Discusses foundation and drainage of roads, methods of work, etc. 4000 w. Surveyor—Sept. 9, 1910. No. 17189 A.

Rectification of a National Highway as a Vicinal Road in l'Aveyron (Rectification d'une Route nationale exécutée comme Chemin vicinal dans l'Aveyron). M. Daudoux. Describes difficult road construction in France. Ills. 3000 w. Ann de Ponts et Chaussées—1910-IV. No. 17209 E + F.

Building the Holyoke Road. Illustrates and describes details of construction of an important highway in Massachusetts. 2800 w. Munic Jour & Engr—Aug. 31, 1910. No. 16831.

Road Construction and Maintenance in Large Cities. Hector F. Gullan. Read at Brussels Int. Road Cong. A discussion of methods and materials and the factors determining their choice. 3000 w. Surveyor—Sept. 2, 1910. No. 17083 A.

Construction and Maintenance of Parkway Roads. John R. Rablin. Presented at Brussels Int. Road Cong. A general description of the methods and materials used in the construction and maintenance of macadam and gravel surfaced roads in the Boston Park System. 2000 w. Engng-Con—Sept. 7, 1910. No. 17027.

The Maintenance of Roads. John M. Lynch. Deals chiefly with the causes of wear, both in the surface and in the under part of the road coating, and the methods of repair. 3000 w. Surveyor—Sept. 9, 1910. Serial. 1st part. No. 17188 A.

Work Preliminary to Road Construction and Street Pavement Maintenance. George C. Warren. Read before the convention of the Am. Soc. of Engng. Contractors. Discusses sources of deterioration from water, and from improper track construction. 2500 w. Engng-Con—Sept. 28, 1910. No. 17521.

Present Status of Dust Prevention on Roads. Gregers-Nissen in *Allgemeine*

Automobil Zeit. Deals particularly with work in Germany. 2000 w. Horseless Age—Sept. 28, 1910. No. 17569.

The Use of Binding Materials in the Construction of Macadamized Roadways. W. W. Crosby. Presented at Brussels Int. Road Cong. Discusses the use of bituminous cement as a binding material, and its proper application. 5500 w. Engng-Con—Sept. 7, 1910. No. 17028.

Bituminous Road Work in Germany. Information from a recent report of replies received to inquiries sent to 89 cities. 3500 w. Eng Rec—Sept. 17, 1910. No. 17156.

Sanitation.

The Contamination of City Air. Dr. George A. Soper. Discusses the dust evil, and other causes of contamination and the remedy, giving much information based on tests. General discussion. Ills. 9500 w. Jour Assn of Engng. Socs—Aug., 1910. No. 17518 C.

See also Drainage, and Mosquitoes, under MUNICIPAL.

Sewage Disposal.

Description of Aerobic Biological Purification of Sewage by Means of the Live Earth Bed System. R. B. Owens. Illustrated description of the system. 1400 w. Can Engr—Sept. 1, 1910. No. 16915.

The Biological Purification of Sewage on Artificial Beds (Notice sur l'Epuration biologique des Eaux d'Egout sur Sol artificiel). A. Loewy. Discusses the theory of sewage purification and describes in detail a number of plants. Ills. 26000 w. Ann d Pont et Chaussées—1910-IV. No. 17204 E + F.

The Operating Control of Sedimentation Plants, from the German Viewpoint. Dr. Ing. Karl Imhoff. Deals with the control of settling basins for sewage treatment. 3000 w. Eng Rec—Sept. 3, 1910. No. 16907.

Sewage Disposal by Dilution. A summary of a chapter on the "Diffusion and Digestion of Sewage in New York Harbor," in the report of the Metropolitan Sewerage Commission of New York, giving much information concerning the discharge of sewage into tidal waters. 2200 w. Munic Jour & Engr—Sept. 14, 1910. Serial. 1st part. No. 17123.

Sewage Disposal at Saskatchewan. T. Aird Murray. Read before the Am. Health Assn. Explains reasons for the methods recommended to prevent stream pollution. 2000 w. Can Engr—Sept. 8, 1910. No. 17029.

Sewage Disposal for a Residential Colony. Illustrated description of a portion of a plant installed at Chevy Chase Lake, Md., giving its capacity and cost. 1500 w. Met Work—Sept. 24, 1910. No. 17387.

The Continued Legislative Defeat of More Stringent Control Over Sewage Disposal in New York State. Editorial discussion of the proposed legislation and its wisdom. 1700 w. Eng News—Sept. 15, 1910. No. 17108.

River Control Commissions in Relation to Sewage Disposal (Flussaufsicht in Bezug auf die Abwässer). Oskar Friedmann. Discusses river control in England, Germany, and Austria, with special reference to the last. 2000 w. Oest Wochenschr f d Oeffent Baudienst—Aug. 6, 1910. No. 17468 D.

Sewers.

Modern Procedure in District Sewer Design. W. W. Horner. An illustrated account of the design and layout of small combination sewers, the problems and importance of the work. 5500 w. Eng News—Sept. 29, 1910. No. 17526.

Drainage Improvements at Syracuse. Illustrated description of the design and construction of an intercepting sewer. 4000 w. Munic Jour & Engr—Sept. 7, 1910. No. 16980.

Louisville Sewer Outlet. Illustrates and describes the outlet structure of the sewerage system at Louisville, Ky., designed to meet unusual conditions. 1400 w. Munic Jour & Engr—Sept. 28, 1910. No. 17520.

Street Cave-in.

A Cave-in Caused by an Underground Stream at Staunton, Va. F. B. van Horn. Illustrated description of the sinking, with discussion of the causes. 1600 w. Eng News—Sept. 1, 1910. No. 16852.

WATER SUPPLY.

Bloemfontein.

Bloemfontein Additional Water Supply. Hastings Fitz Edward Peet. Explains conditions in this part of South Africa, and describes the scheme adopted for an additional water supply. Ills. 2500 w. Inst of Civ Engrs—No. 3746. No. 17371 N.

Dams.

Discharge Measurements and Formulas for Some Large Overflow Dams. W. F. Martin. Illustrated article giving useful data of value to hydraulic engineers and for other uses. 4000 w. Eng News—Sept. 29, 1910. No. 17524.

Rolling Dams for Irrigation in Mexico. Illustrated detail description of an unusual type of rolling dam. 700 w. Eng Rec—Sept. 10, 1910. No. 17052.

Construction Plant and Methods for Building an 85000 Cu. Yd. Rubble Concrete Dam. Illustrated description of the storage reservoir of 2,750,000,000 cu. ft. capacity near Rome, N. Y., to supply water for the Barge Canal. 2000 w. Engng-Con—Sept. 21, 1910. No. 17349.

Filtration.

A New Recording Loss of Head Gage for Sand Filters. F. B. Leopold. Illustrated description of a type which gives the actual loss irrespective of variation of water level above the sand bed. 800 w. Eng News—Sept. 29, 1910. No. 17528.

We supply copies of these articles. See page 327.

Modern Filter Plants. Langdon Pearse. Read before the Ill. Water Supply Assn. Illustrates and describes typical plants of the mechanical or rapid filter type and of the slow sand type. 1500 w. Can Engr—Sept. 22, 1910. No. 17410.

Operating Results of the Bubbly Creek Filter Plant, Chicago. C. A. Jennings. The chief chemist and superintendent of the interesting plant at the Chicago stock yards gives information concerning the efficiency, cost and methods of operating. Also editorial. 5000 w. Eng Rec—Sept. 24, 1910. No. 17400.

Results of Double Filtration Experiment at Albany. A detailed report of the experiments made and the results. 3500 w. Eng Rec—Sept. 3, 1910. Serial. 1st part. No. 16903.

Fire Protection.

Fire Hose Tests at the Underwriters' Laboratories, Chicago, Ill. William H. Merrill. From an address delivered before the Int. Assn. of Fire Engrs., at Syracuse, N. Y., on "The Objects of Tests and Investigations at Underwriters' Laboratories." 2200 w. Eng News—Sept. 8, 1910. No. 17003.

Forestry.

Forestry. L. W. Goodrich. Considers the relation of forestry to water-works, reviewing the conditions in the vicinity of Hartford, Conn., and the treatment recommended by foresters. Ills. Discussion. 8800 w. Jour N Eng W-Wks Assn—Sept., 1910. No. 17338 F.

Great Britain.

The Water Supplies (Protection) Bill, 1910, as Affecting the National Water Supply. E. Bailey-Denton, and George Lowthian. A discussion of conditions relating to the water supply and the legislation needed. 2000 w. Engng—Aug. 26, 1910. No. 16966 A.

Ground Waters.

The Influence of Underground Waters on Health. Baldwin Latham. Read before the Roy. San. Inst. Discusses records of well measurements, prevention of pollution, influence of low water, water and disease, etc. General discussion. 4000 w. Surveyor—Sept. 16, 1910. No. 17421 A.

Irrigation.

Irrigation by Pumping on the Patterson Ranch. G. C. Stevens. Brief illustrated description of a water supply taken from the San Joaquin River by pumping. 2500 w. Eng Rec—Sept. 10, 1910. No. 17043.

Jersey City.

Water-Pollution and Water-Purification at Jersey City, N. J. C. E. A. Winslow. A review of facts brought out in the lawsuit regarding the Jersey City water supply. Discussion. Map. 8500 w. Jour W Soc of Engrs—Aug., 1910. No. 17332 D.

Lake Michigan.

Quality of Lake Michigan as a Water-Supply for the North Shore District. Extracts from a paper by Langdon Pearse, giving results of a sanitary survey made of the part of the lake supplying water to the residential towns north of Chicago. 2500 w. Eng News—Sept. 29, 1910. No. 17525.

Pipe Storage.

The Municipal Pipe Yard at San Francisco. Illustrates and describes arrangements for storing and testing 45,000 tons of pipe, hydrants and special castings. 5000 w. Eng Rec—Oct. 1, 1910. No. 17588.

Pipe Tunnels.

Water Pipe Tunnels in Milwaukee. Explains conditions and gives illustrated description of method adopted and of construction. 1600 w. Eng Rec—Sept. 3, 1910. No. 16911.

Pollution.

The Acid Waters of Western Pennsylvania. From a paper by E. C. Trax, before the Cent. States W.-Wks. Assn. Brief discussion of the sources of pollution which tend to produce free mineral acid in these waters. 2000 w. Eng Rec—Oct. 1, 1910. No. 17591.

Purification.

Hypochlorite Treatment of Public Water Supplies; Its Adaptability and Limitations. George A. Johnson. Read before the Am. Pub. Health Assn. A summary of the present state of the system, discussing its merits and limitations. 5500 w. Eng Rec—Sept. 17, 1910. No. 17154.

Removing Iron from Water. An account of the treatment of well water at Fort Hancock. Aeration not successful. Use of calcium hydrate and filtration adopted successfully. 1800 w. Munic Jour & Engr—Sept. 7, 1910. No. 16981.

Some Experience in Treating High-Colored Water from the Penobscot River at Bangor, Me. Abstract from report of James M. Caird, giving experience with this water. 2800 w. Engng-Con—Aug. 31, 1910. No. 16857.

The Water Purification Plant of the Chicago Stock Yards. A review of the conditions as to the water purification plant, giving both the view of the stock yards company, and of the city. 2000 w. Eng News—Sept. 8, 1910. No. 16999.

The Chicago Stock Yards Water Purification Litigation. A letter from George A. Johnson discussing the chief issues which developed during the recent trial. 3500 w. Eng News—Sept. 29, 1910. No. 17530.

Reservoirs.

Concrete-Lined Reservoirs in Seattle. Illustrates and describes details of four concrete-lined reservoirs constructed for the municipal water-works system. 2500 w. Eng Rec—Sept. 24, 1910. No. 17403.

New Central Reservoir of the People's Water Company. L. L. Mills. Illustrated description of the construction at Oakland, Cal., of perhaps the largest lined reservoir on the Pacific Coast. 1500 w. Eng Rec—Oct. 1, 1910. No. 17594.

We supply copies of these articles. See page 327.

Failure of a Reinforced-Concrete Reservoir. Ernest Macartney de Burgh. An illustrated description of the reservoir, and statement of conclusions in regard to the failure. 3500 w. Inst of Civ Engrs—No. 3846. No. 17370 N.

The Ancient Irrigation and Water-Supply Tanks or Reservoirs of Ceylon. W. G. Bligh. An illustrated sketch of reservoirs constructed before the Christian era, with a brief historical review of this island and present conditions. 6500 w. Eng News—Sept. 22, 1910. No. 17351.

Secondary Supplies.

Secondary Water Supplies, Their Dangers and Value. A topical discussion, with a statement as to what secondary supplies are. Ills. 13500 w. Jour N Eng W-Wks Assn—Sept., 1910. No. 17339 F.

Sterlization.

A Sterilization Plant for Turbid Water. Describes a plant at Council Bluffs, Ia., for the treatment of Missouri River water. 1400 w. Eng Rec—Sept. 17, 1910. No. 17160.

Sterilization of Polluted Water by Ultra-Violet Rays. Kenneth C. Grant. Describes experiments in progress in the laboratory of The Sorbonne, at Paris, for the commercial sterilization of water for domestic uses, by applying ultra-violet rays. Ills. 1000 w. Eng News—Sept. 15, 1910. No. 17105.

Sterilization of Water by Means of Quartz Lamps. Max von Recklinghausen. Reviews the lamps for artificially producing ultra-violet light and their application to sterilization. Ills. 1200 w. Elec Rev, Lond—Sept. 2, 1910. No. 17076 A.

Stream Flow.

Graphical Determination of the Flow of Water in Open Canals (Grafische Berekening voorden Afvoer in open Kanalen). P. Th. L. Grinwis Plaat. A mathematical discussion, with a large chart of the Darcy and Bazin formula. Ills. 5000 w. De Ingenieur—Aug. 27, 1910. No. 17506 D.

Typhoid Fever.

Typhoid Fever in Paris and Its Environs (La Fièvre Typhoïde à Paris et en Banlieue). Paul Vincey. A comprehensive discussion of water-supply sanitation in Paris. 9500 w. Bul Soc d'Encour—July, 1910. No. 17215 G.

Water Towers.

Constructing a Concrete Standpipe. Illustrated description of a reinforced concrete standpipe recently completed at Westerly, R. I., its design and construction. 1000 w. Munic Jour & Engr—Sept. 21, 1910. No. 17379.

See also same title, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Water Works.

I. Annual Convention of the New England Water-Works Association. II. Convention of the Central States Water-Works Association. Gives abstracts of papers at these two conventions, with editorial discussion of "Some Water-Works Questions of the Day." 8000 w. Eng News—Sept. 29, 1910. No. 17529.

Mexico City's New Water Works System. Robert H. Murray. Illustrated description of the new supply. 1000 w. Sci Am—Sept. 24, 1910. No. 17363.

Hankow Water-Works. Richard St. George Moore. Description of the works, with illustrations. 4000 w. Inst of Civ Engrs—No. 3853. No. 17368 N.

Supplementary Works for the Water-Supply of Jeypore, Rajputana. Charles Egremont Stotherd. Brief description. 500 w. Inst of Civ Engrs—No. 3837. No. 17372 N.

Water Works Valuation.

Some Rules for Water-Works Appraisals. Opinion of U. S. Supreme Court, delivered by Judge Lurton, in City of Quebec v. Omaha Water Co. 4800 w. Eng Rec—Sept. 10, 1910. No. 17050.

Valuation of the Fond-du-Lac Water-Works. Reviews the principles on which the Railroad Commission of Wisconsin based its findings. 3500 w. Eng Rec—Sept. 3, 1910. No. 16909.

WATERWAYS AND HARBORS.

Canals.

The Rafting of Timber on Canalized Rivers (Flossholtztransport auf kanalisierten Flüssen). Discusses conditions in Austria. 8000 w. Oest Wochenschr f d Oeffent Baudienst—Aug. 27, 1910. No. 17469 D.

Débris Barrier.

The Failure of the Yuba River Débris Barrier, and the Efforts Made for Its Maintenance. On the failure of this structure constructed for the control of hydraulic mining in California. Ills. 3000 w. Pro Am Soc of Civ Engrs—Sept., 1910. No. 17558.

Diving.

The Physics of Diving. Abstracted from "Submarine Appliances and Their Uses, etc." Illustrated description of curious effects of water pressure, showing types of diving dresses. 2000 w. Sci Am Sup—Oct. 1, 1910. No. 17540.

Docks.

Dock and Wharf Equipment. John Llewellyn Holmes. Deals with equipment for the landing and shipping, storage and delivery of mixed or general cargo, excluding bulk cargoes. Ills. 2500 w. Inst of Civ Engrs—No. 3850. No. 17374 N.

Novel Submarine Concrete Work. Frank C. Perkins. Illustrates and describes a pontoon method of concrete construction at Goderich, Canada. 1500 w. Sci Am Sup—Sept. 17, 1910. No. 17133.

Dry Docks.

The Otago Graving Dock, Port Chalmers, New Zealand. Robert Hay. Brief

description. 1200 w. Inst of Civ Engrs—No. 3854. No. 17373 N.

An Electrically Operated Floating Dry Dock. Illustrated description of the Robins dock at Brooklyn, N. Y. 800 w. Elec Rev, N Y—Sept. 3, 1910. No. 16890.

Flood Prevention.

Vienna Continually Threatened by the Danube (Wien von den Hochfluten der Donau dauernd bedroht). Anton Waldvogel. Outlines the history of Danube floods, shows Vienna's danger, and discusses means of protection. Discussion. Ills. 2500 w. Zeitschr d Oest Ing u Arch Ver—Aug. 12, 1910. No. 17463 D.

The Protection of Vienna Against the Danube Floods (Der Schutz von Wien gegen die Hochwässer der Donau). Ernst Lauda. Two papers, with discussion, on the regimen of the Danube, and the flood-prevention works projected. Ills. 3000 w. Zeitschr d Oest Ing u Arch Ver—Aug. 12, 1910. No. 17462 D.

Floods.

Report of the Paris Flood Commission (Le Rapport de la Commission chargée de Rechercher les Causes des Inondations et les Moyens d'en Empêcher le Retour). A. Dumas. A review of the report of a Commission appointed to investigate the causes of floods and means of prevention. Ills. 7000 w. Génie Civil—Aug. 13, 1910. No. 17235 D.

Leghorn.

The Leghorn Harbor Project (Il Piano regolatore del Porto di Livorno). Describes the work recently initiated. Ills. 5200 w. Ing Ferro—Aug. 1, 1910. No. 17247 D.

Levees.

East Side Levee and Sanitary District, East St. Louis. Describes the levee and drainage project and gives reasons for the large expenditure involved. 2000 w. Eng Rec—Sept. 17, 1910. No. 17155.

Manzanillo.

Port of Manzanillo. M. L. Gilmore. Illustrated description of the Pacific coast port of the National Railroads of Mexico, with information regarding it. 1800 w. Marine Rev—Sept., 1910. No. 17127.

Mechanical Locks.

Hoisting Boats Electrically. Frank C. Perkins. Illustrates and describes the Anderton electric-driven canal-boat elevator. 2000 w. Sci Am Sup—Sept. 3, 1910. No. 16870.

Reconstruction of Canal-Boat Lift on the River Weaver at Anderton. John Arthur Saner. An account of the reconstruction in 1906-8. Ills. 4000 w. Inst of Civ Engrs—No. 3860. No. 17375 N.

Panama Canal.

Recent Progress at Panama. Fullerton L. Waldo. An illustrated report of recent personal observations. 2500 w. Engineering Magazine—Oct., 1910. No. 17546 B.

Piers.

Costs of Building a Timber Pleasure Pier on Pile Bends. Benjamin Brooks. Data in regard to a small pleasure pier on the coast of California. 1400 w. Engng-Con—Sept. 28, 1910. No. 17523.

The Reconstruction of the Tyne North Pier. Ivan Collingwood Barling. Reviews the history of the Tyne harbor works, specially considering the reconstruction of the outer portion of the north pier, and the reinstatement of a further length shoreward. Also general discussion. Ills. 34500 w. Inst of Civ Engrs, No. 3857—Jan. 25, 1910. No. 17365 N.

Pollution.

The Sewage Question and Treatment of Trade Effluents. John D. Watson. Read before the Roy. San. Inst. Discusses British laws relating to the pollution of rivers, and alterations needed. 3500 w. Surveyor—Sept. 16, 1910. No. 17420 A.

Soil Erosion.

The Mechanism of River Beds. V. Lokhtine. A study of the mechanical action of rivers. Ills. 4500 w. Cassier's Mag—Sept., 1910. Serial. 1st part. No. 17164 B.

Tides.

The Field and Cust Tide-Recorder. Illustrated description of a new design. 1200 w. Engng—Aug. 26, 1910. No. 16963 A.

Floats for Studying Tides. Illustrates and describes the kinds of floats used by the Metropolitan Sewerage Commission of New York, and their methods of study. 1500 w. Munic Jour & Engr—Sept. 7, 1910. No. 16984.

Trieste.

Report of a Student Excursion to the Trieste Harbor Works (Bericht über die Studienreise Zur Besichtigung der Triester Hafenanlagen). A brief description of the harbor works and recent improvements. Ills. Serial. 1st part. 3000 w. Zeitschr d Oest Ing u Arch Ver—Aug. 19, 1910. No. 17465 D.

Water Powers.

Water-Power Sites. Extract from a speech by President Taft at St. Paul, on the government's duty to prevent monopoly and extortionate charges. 1300 w. Eng Rec—Sept. 10, 1910. No. 17048.

The Prevention of Power Monopoly. Herbert Knox Smith. Extracts from a speech at St. Paul, on the water powers of the United States and hydroelectric development. 2000 w. Eng Rec—Sept. 10, 1910. No. 17045.

Wharves.

Ligno-Concrete: An Early Form of Reinforced Construction. Thomas Parker. Describes a method of wharf-building in Australia, which claims entire protection against the teredo. 500 w. Sci Am—Sept. 10, 1910. No. 17019.

We supply copies of these articles. See page 327.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radiotelegraphy.

Wireless Telegraphy and Telephony. H. Marchand. A review of progress since 1908. 1800 w. Sci Am Sup—Sept. 17, 1910. No. 17115.

Recent Patents in Wireless Telegraphy. W. H. Eccles. A review of recent improvements and their benefits. Ills. 2000 w. Elect'n, Lond—Sept. 2, 1910. Serial. 1st part. No. 17079 A.

Recent Progress in Radiotelegraphy and Radiotelephony (Progrès récents en Radiotélégraphie et Radiotéléphonie). H. Marchand. A review of progress during 1909. 2500 w. Rev Gen d Sci—Aug. 15, 1910. No. 17221 D.

Propagation of Electric Ether Waves. F. G. Cresswell. Read before the Vic. Inst. of Elec. Engrs. Considers mechanical vibration as applied to ether waves used in wireless telegraphy. 1500 w. Aust Min Stand—Aug. 3, 1910. No. 16978 B.

Abnormal Transmission of Electromagnetic Waves. Paul Schwarzhaupt. Abstract translation from *Elek. Zeit.* Reports observations of variations in intensity. 700 w. Elect'n, Lond—Aug. 26, 1910. No. 16952 A.

Commercial Wireless Telegraphy in Japan. Wichi Torikata. An account of the development with illustrated description of the Teishinsho system. It is a spark system as regards its transmitter, and uses a telephone and detector for its receiver. 3000 w. Elect'n, Lond—Sept. 16, 1910. No. 17431 A.

An Oscillation Detector Actuated Solely by Resistance Temperature Variations. W. H. Eccles. Abstract of paper read before the Phys. Soc. Describes experiments on a detector of the crystal rectifier type. 1000 w. Elect'n, Lond—Aug. 26, 1910. No. 16948 A.

Effect of Damping Factor Upon the Sensibility of Detectors in Wireless Telegraphy. H. H. Gordon. A report of tests made at the experimental wireless station of George Washington University. 1600 w. Elec Rev, N Y—Sept. 10, 1910. No. 17068.

Natural and Forced Air Circulation Across Spark-Gaps. Illustrated description of a spark-gap ventilating system which is said to increase greatly the efficiency of a wireless transmitter. 700 w. Elec Wld—Sept. 29, 1910. No. 17534.

Coherers and Their Applications to Radiotelegraphy and Telemechanics (Les Radioconducteurs et leurs Applications à la Télégraphie et à la Télédynamique sans Fil). E. Branly. Discusses their theory, construction, operation and uses. Ills. 7600 w. Bul Soc d'Encour—July, 1910. No. 17216 G.

Wireless for a Transatlantic Airship. F. M. Sammis. Illustrates and describes the equipment for the dirigible balloon *America*. 700 w. Elec Wld—Sept. 8, 1910. No. 16993.

Wireless Transmission of Time Signals from the Paris Observatory to Residences and Ships (L'Heure de l'Observatoire de Paris reçue à Domicile et à Bord des Navires par la Télégraphie sans Fil). M. Aliamet. Describes the wireless time service from the Eiffel Tower. Ills. 2400 w. L'Elecn—Aug. 20, 1910. No. 17227 D.

See also Wave Meters, under MEASUREMENT.

Telegraphy.

The Santano Duplex System of Telegraphy for Aerial Lines (Telegrafia Duplex por Lineas aéreas, sistema Santano). Miguel Pérez Santano. Begins a description of the author's system. Ills. Serial. 1st part. 1500 w. Energia Elec—Aug. 10, 1910. No. 17250 D.

Telephone Exchanges.

New Post Office Telephone Exchange, Glasgow. Illustrated description of a new exchange on the common-battery system. 1200 w. Elec Rev, Lond—Aug. 26, 1910. Serial. 1st part. No. 16943 A.

Telephony.

Central-Battery versus Magneto Systems in Small Exchanges. E. A. Hawkins and E. M. Wier. Abstract of paper before the So. Ind. Tel. Assn. Compares them from service and cost standpoints. 4000 w. Elec Rev, N Y—Sept. 3, 1910. No. 16892.

DYNAMOS AND MOTORS.

A. C. Motors.

Three-Phase Commutator Motors with Speed Regulation (Drehstromkollektormotoren mit regelbarer Umlaufzahl). Describes the construction and testing of the Winter-Eichberg motor at the works of the Union E.-G. Ills. 2000 w. Zeitschr d Ver Deutscher Ing—Aug. 20, 1910. No. 17497 D.

D. C. Dynamos.

How to Design a Constant-Potential Direct-Current Dynamo. W. T. Ryan. A brief statement of the fundamental principles upon which the design necessarily rests. 2500 w. Elec Rev, N Y—Sept. 17, 1910. Serial. 1st part. No. 17170.

Parallel Operation of Direct Current Generators. C. L. Greer. Gives requisites for satisfactory operation. Ills. 1400 w. Power—Sept. 27, 1910. No. 17513.

Exhibitions.

Electrical Machines from the Netherlands at the Brussels Exposition (Eenige

We supply copies of these articles. See page 327.

Mededeelingen over electrische Machines in de Nederlandsche Afdelling der Internationale Machinegalerij op de Wereldtenoonstelling te Brussel). Th. Rosskopf. Illustrated description of the exhibits. 5000 w. De Ingenieur—Aug. 13, 1910. No. 17504 D.

Failures.

Breakdowns of Electrical Machinery. Michael Longridge. A summary of some of the more important and instructive cases of breakdown during the year 1909. Ills. 3000 w. Mech Engr—Sept. 2, 1910. No. 17087 A.

Induction Motors.

Variable Speed Induction Three-Phase Motor with Five-Speed Steps. Illustrated description of the construction of the Oerlikon variable-speed induction motor. 1000 w. Prac Engr—Sept. 9, 1910. No. 17187 A.

Iron Losses.

Iron Losses in Rotary Magnetization (Die Eisenverluste bei drehender Magnetisierung). R. Hiecke. Discusses recent papers on iron losses by Herrmann and Czepek. Ills. 3500 w. Elektrotech u Maschinenbau—Aug. 14, 1910. No. 17485 D.

Railway Motors.

The Destinies of 500-Volt D. C., 1200-Volt D. C., and 6600-Volt A. C. Motors. W. E. Davis. Abstract of paper before the Cent. Elec. Ry. Assn. Remarks on the rapid development in the production and distribution of electrical energy and the future outlook. 2500 w. Elec Ry Jour—Sept. 24, 1910. No. 17391.

Repulsion Motors.

Single-Phase Commutator Motor. Shiro Sano. Considers the effect of extra reactance in the armature circuit on the performance of the repulsion motor. 2000 w. Elec Wld—Sept. 8, 1910. No. 16994.

Speed Regulation.

See Electric Pumping, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Standard Apparatus.

Standard Apparatus. Rudolph E. Hellmund. Suggestions for its use in connection with special frequencies, wherever conditions will allow. 5000 w. Elec Jour—Sept., 1910. No. 16823.

ELECTRO-CHEMISTRY.

Electric Furnaces.

The Oerlikon Electric Crucible Furnace (Fours électriques à Creuset Oerlikon). J. A. Montpellier. Brief description. Ills. 1500 w. L'Elecn—Aug. 27, 1910. No. 17228 D.

Electroplating.

Notes on the Method Employed for Refinishing Old Chandeliers and Gas Fixtures. Illustrated directions for the work. 2000 w. Brass Wld—Sept., 1910. No. 17140.

Nitrogen.

The Industrial Fixation of Atmospheric Nitrogen (Fixation industrielle de l'Azote atmospherique). E. Lamy. Describes the various processes and the products, and examines the economic possibilities of nitrogen fixation. Ills. 8000 w. Mem Soc Ing Civ de France—July, 1910. No. 17202 G.

ELECTRO-PHYSICS.

Cells.

Dry Cell Tests. F. H. Loveridge. Abstract of paper read before the Am. Elec-Chem. Soc. Gives data regarding the fall of E. M. F. and increase in internal resistance of dry cells under ordinary working conditions. 2500 w. Elect'n, Lond—Aug. 26, 1910. No. 16947 A.

Coherers.

See also Radiotelegraphy, under COMMUNICATION.

Electromechanics.

The Laws of Electromechanics. Prof. Silvanus P. Thompson. Abstract of a paper before the British Assn. A summary of the laws governing electromagnetic apparatus, pointing out some of the relations between them. 800 w. Elect'n, Lond—Sept. 16, 1910. No. 17432 A.

High-Tension Discharges.

A New Method for Producing High-Tension Discharges. Prof. Ernest Wilson and W. H. Wilson. Read before the British Assn. Brief explanation, with statement of advantages gained. 600 w. Elect'n, Lond—Sept. 9, 1910. No. 17300 A.

Hysteresis.

Hysteresis. Reference is made to a paper by Morton G. Lloyd, before the Franklin Institute, on the bearing hysteresis loss has upon the design of electrical machines. Briefly considers core material, especially "Stalloy." 1500 w. Engr, Lond—Sept. 2, 1910. No. 17099 A.

Physical Quantities.

Physical Quantities. Classified in the Order of Their Dimensional Formulas. Carl Hering. Tabulated classifications, with notes. 2500 w. Jour Fr Inst—Sept., 1910. No. 17335 D.

GENERATING STATIONS.

Accumulators.

Storage Batteries in Army and Navy Service. E. L. Reynolds. Brief review of some recent uses by the British Government, with details of construction and operation. 1500 w. Elec Engr, Lond—Sept. 2, 1910. No. 17075 A.

Auxiliary Plants.

Internal-Combustion Engines in Water-Power Plants (Die wirtschaftliche Bedeutung des Verbrennungsmotors für die Ausnutzung von Wasserkräften). Compares the advantages of Diesel motors and steam engines as auxiliaries in hydro-electric plants. Ills. 1500 w. Die Turbine—Aug. 5, 1910. No. 17298 D.

We supply copies of these articles. See page 327.

Boosters.

Limited-Current Boosters in Buffer Installations (Zusatzmaschinen mit Strombegrenzung in Pufferanlagen). J. Jonas. A discussion of the use of a booster in connection with storage batteries, with special reference to booster excitation. Ills. 2800 w. Elek Kraft u Bahnen—Aug. 4, 1910. No. 17477 D.

Central Stations.

Central-Station at Attleboro, Mass. Illustrated description of a station where steam turbines displaced reciprocating engines in an installation of moderate size. 2500 w. Elec Wld—Sept. 15, 1910. No. 17136.

Turbine Station of the Bisbee Improvement Company. I. A. Rosok. Gives results obtained in the operation of a small Arizona oil-burning plant, with details of losses and their distribution. Ills. 2000 w. Elec Wld—Sept. 22, 1910. No. 17358.

Gas and Oil-Burning Electric Power Station. Illustrates and describes the modern equipment of the Light and Traction Co., of Fort Smith, Ark. 2500 w. Elec Wld—Sept. 1, 1910. No. 16842.

Electricity Supply in Maceio, Brazil. Andrew McPherson. Illustrated description of the electric lighting system, as an example of what can be done in medium-sized towns of S. America. 2000 w. Elec Rev, Lond—Sept. 9, 1910. No. 17195 A.

Mechanical Features of a Power Plant at Landy, France. Warren H. Miller. Illustrates and describes an installation for electric light and power. 2800 w. Eng Rec—Sept. 3, 1910. No. 16905.

Design.

Elements of Power-Station Design. W. B. Gump. The present number discusses preliminary considerations and requirements. 4800 w. Elec Rev, N Y—Sept. 3, 1910. Serial. 1st part. No. 16891.

Economics.

Restricted-Hour System of Power Supply. P. J. Pringle. Presents the advantages and possibilities of this system of supply. 3500 w. Elec Rec, Lond—Aug. 26, 1910. Serial. 1st part. No. 16945 A.

Hydro-Electric.

Hydro-Electric Installations of Sweden. Aubrey V. Clayton. Abstract of paper before the Inst. of Elec. Engrs. Illustrates and describes some of the plants. 4000 w. Mech Engr—Sept. 2, 1910. Serial. 1st part. No. 17086 A.

The Ventavon Hydro-Electric Plant (L'Usine hydraulico-électrique de Ventavon, Hautes-Alpes). M. de Kermond. Brief description of a 24,000 horse-power plant on the durance, in Southern France. Ills. 2000 w. L'Elecn—Aug. 27, 1910. No. 17229 D.

The Aue Power Plant of the Baden Electric Company (Die Wasserkraftanlage Aue der Elektrizitätsgesellschaft Baden). Illustrated description. Serial. 1st part. 1500 w. Schweiz Bau—Aug. 20, 1910. No. 17297 B.

The Realization of the Walchensee Power Plant (Die Verwirklichung des Walchensee-Kraftwerkes) A review of this important power project in Bavaria. Ills. 2000 w. Deutsche Bau—Aug. 3, 1910. No. 17291 B.

The Hydro-Electric Plant at the Salto de Bolarque (Das Wasserkraft-Elektrizitätswerk am Salto de Bolarque). K. Meyer. Detailed description of the plant at this fall on the Tajo, Spain. Ills. Serial. 1st part. 3300 w. Zeitschr d Ver Deutscher Ing—Aug. 20, 1910. No. 17495 D.

Isolated Plants.

A Recent Isolated Plant Installation for Country Residence Lighting. W. D. Cassin. Brief description of a plant for an estate near Annapolis, Md. 500 w. Elec Wld—Sept. 8, 1910. No. 16992.

The Power Plant of the Bigelow Carpet Company. Illustrated description of a new plant at Clinton, Mass., to run two mills an eighth of a mile apart. 1800 w. Eng Rec—Sept. 17, 1910. No. 17157.

Regulations.

Standard Rules for the Construction and Operation of Electrical Plants Adopted 1910 by the Italian Electrical Association (Testo definitivo delle Norme per l'Esecuzione e l'Esercizio degli Impianti elettrici Adottato nell'Anno 1910). Gives the full text of the rules. Serial. 1st part. 1500 w. Industria—Aug. 21, 1910. No. 17245 D.

Rates.

Demand and Diversity Factors and Their Influence on Rates. J. R. Cravath. A brief study, giving some of the available figures. 3500 w. Elec Wld—Sept. 8, 1910. No. 16995.

The Price of Electricity. Edw. W. Cowan. Slightly abbreviated paper read before the Economic Sec. of the British Assn. Criticises the principles on which the charges are based, and favors classified tariffs. 2500 w. Elect'n, Lond—Sept. 9, 1910. Serial. 1st part. No. 17199 A.

The Price of Electricity. A summary of a paper by Edw. W. Cowan, read before the Economic Sec. of the British Assn. With notes on the paper and discussion. 3000 w. Elec Rev, Lond—Sept. 9, 1910. No. 17196 A.

The Rate Problem in Municipal Plants (Zur Tariffrage für Städtische gewerbliche Anlagen). Kasimir Gajczat. A discussion of the problem of rate fixing in municipal light and power plants. 3500 w. Elektrotech u Maschinenbau—Aug. 21, 1910. No. 17486 D.

Switches.

High-Tension Oil Switches (Hochspannung-Oelschalter). Describes the types manufactured by the Felten & Guilleaume-Lahmeyerwerke. Ills. 2300 w. Elektrotechniker—Aug. 25, 1910. No. 17472 D.

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LIGHTING.

Arc Lamps.

Applications of the Electric Arc. A. J. Mitchell. A résumé of the developments in arc lamp electrodes, considered only as a source of light. 2200 w. Elec Rev, N Y—Sept. 10, 1910. No. 17066.

Illumination.

Modern Lighting. C. Toome. Gives tables of illumination data and a design chart which the writer has compiled, with notes. 1800 w. Elec Rev, Lond—Sept. 9, 1910. No. 17197 A.

Lighting of Schools. Discusses the effect on the health, and on the eye-sight, with suggestions. 2000 w. Elec Wld—Sept. 8, 1910. No. 16996.

Lighting the Morgan Art Galleries at Hartford. Describes the novel lighting of these art galleries, illustrating new ideas as applied to indirect lighting. 1700 w. Elec Rev, N Y—Sept. 10, 1910. No. 17064.

Incandescent Lamps.

The Reflecting Power of Various Metals. W. W. Coblentz. Reports experiments to obtain knowledge of the optical properties of the metals used in incandescent lamps. 7000 w. Jour Fr Inst—Sept., 1910. No. 17334 D.

Discussion on "Metal Filament Lamps," New York, May 17, 1910. Discussion of John W. Howell's paper. 5000 w. Pro Am Inst of Elec Engrs—Sept., 1910. No. 17343 F.

Tungsten Lamps. G. S. Merrill. Describes the process of producing these lamps and the care required. Also shows the performance of the lamps in service, explaining the reason of the high efficiency. 4500 w. Pro Am Inst of Elec Engrs—Sept., 1910. No. 17340 F.

Development and Application of the Tungsten Lamp for Sign Lighting in Minneapolis, Minn. Robert W. Clark. An illustrated account of development. 1800 w. Elec Wld—Sept. 1, 1910. No. 16845.

Comparative Life Test of Incandescent Lamps. Clayton H. Sharp and Preston S. Millar. Shows the agreement of British and American methods of making life tests. 1500 w. Elec Wld—Sept. 22, 1910. No. 17359.

Comparative Life Tests on Glow Lamps. C. C. Paterson and E. H. Rayner. A report of tests undertaken to determine the agreement which it is possible to obtain when life tests are carried out on glow lamps at different laboratories. 1200 w. Elect'n, Lond—Sept. 9, 1910. No. 17198 A.

Lighting by Incandescence (L'Eclairage par Incandescence). Capt. Nicolardot. Discusses recent progress in the materials, processes of manufacture, and efficiency of incandescent lamps. Ills. 7500 w. Tech Mod—Aug., 1910 (Sup.). No. 17223 D.

Mercury Vapor Lamps.

The Quartz-Tube Mercury Arc Lamp. J. G. Zimmerman. Illustrated description of this lamp and its operation. 2000 w. Elec Rev, N Y—Sept. 10, 1910. No. 17065.

See also Sterilization, under CIVIL ENGINEERING, WATER SUPPLY.

Photometry.

The Status of Heterochromatic Photometry. Herbert E. Ives. Reviews present knowledge of comparing illuminations of different colors, and outlines experimental work yet needed. 4500 w. Elec Rev, N Y—Sept. 10, 1910. No. 17063.

Photo-Electric Properties of the Alkali Metals. F. K. Richtmyer. Abstract of two papers read before the Am. Phys. Soc. Describes experiments to ascertain the dependence of photo-electric current on the wave-lengths of the incident light, and suggests useful applications of the photo-electric properties of alkali metals. 2000 w. Elect'n, Lond—Aug. 26, 1910. No. 16949 A.

Signs.

Animated Electric Advertising Sign. S. D. Levings. Illustrated description of work in this field. 1500 w. Elec Wld—Sept. 29, 1910. No. 17535.

Street.

Street Illumination. James R. Cravath. Deals principally with electric lighting and the relation and arrangement of lamps. Short discussion. 4000 w. Jour Assn of Engng Socs—July, 1910. No. 16827 C.

Some Recent Tendencies in Street Lighting. Louis Bell. On the use of improved illuminants, discussing their arrangement, location, and related matters. 2200 w. Elec Rev, N Y—Sept. 10, 1910. No. 17067.

Ornamental Street Lighting in the Middle West. Illustrates and describes attractive arrangements of the lighting units, and gives tabulated data of cost, operation, etc. 1000 w. Elec Wld—Sept. 15, 1910. No. 17138.

Ornamental Street Lighting. Abstract of a paper by E. Darrow, read before the Indiana Elec. Lgt. Assn. Illustrated discussion of the kinds of illuminants and the cost of operation. 2500 w. Elec Wld—Sept. 8, 1910. No. 16997.

Street-Lighting Practice in Massachusetts. Gives details of street-lighting service in a number of the larger cities served by private plants. 4000 w. Elec Wld—Sept. 1, 1910. No. 16844.

MEASUREMENT.

Dynamometers.

See also same title, under MECHANICAL ENGINEERING, MEASUREMENT.

Insulation Testing.

Defects in the Voltmeter Method of the Measurement of Insulation Resistance. Arthur J. Rowland. Points out some of

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the limitations and defects of the voltmeter. 1600 w. Elec Wld—Sept. 1, 1910. No. 16843.

Laboratories.

Physical Laboratory of the National Electric Lamp Association. Illustrates and describes a laboratory in Cleveland, Ohio, for research in illumination and electric lighting. Also a sketch of the life of the director, Dr. Edward P. Hyde. 3500 w. Elec Rev, N Y—Sept. 10, 1910. No 17062.

Potentiometers.

The Drysdale-Tinsley Alternating-Current Potentiometer (Potentiomètre Drysdale-Tinsley pour Courant alternatif). M. Aliamet. Discusses the theory, construction, and uses of the instrument. Ills. 2700 w. L'Elecn—Aug. 6, 1910. No. 17225 D.

Power Factor.

Practical Notes on New Methods of Measuring Apparent Power and Power Factor (Considerazioni pratiche per l'Applicazione dei nuovi Metodi di Misura industriale della Potenza apparenté e del Fattore di Potenza). Riccardo Arno. Discusses the use of watt meters, volt-coulomb meters and phase meters. Ills. 2500 w. Monit Tech—Aug. 30, 1910. No. 17241 D.

Resistance.

See Thermometry, under MEASUREMENT.

Station.

The Wil Measurement Station of the Kubel Electrical Plant (Die Messtation Wil des Elektrizitätswerkes Kubel). F. Largiarder. Describes the equipment of a large measuring plant on an extensive transmission network in Switzerland. Ills. 2000 w. Schweiz Bau—Aug. 13, 1910. No. 17296 B.

Thermometry.

Electrical Recording Thermometers for Clinical Work. H. L. Callendar. Abstract of presidential address to the Physical Soc. Discusses conditions of sensitiveness in measuring a resistance by the Wheatstone bridge method, and describes the construction of electrical resistance thermometers and recorders for clinical work. Ills. 5500 w. Elect'n, Lond—Sept. 2, 1910. No. 17081 A.

Wave Meters.

The Development of the Wave-Meter in Wireless Telegraphy. George Seibt. Discusses the history of wave-meter development. Ills. 2500 w. Elec Wld—Sept. 29, 1910. No. 17533.

POWER APPLICATIONS.

Organ Blower.

Organ Blowing by Means of Electricity. Illustrates and describes the Sentinel organ blower, installation and its operation. 1200 w. Elec Rev, Lond—Sept. 9, 1910. No. 17194 A.

TRANSMISSION.

Cables.

Notes on High-Tension Underground Cables. R. E. Neale. Considers methods of laying underground mains, life and causes of breakdowns, the limiting and test voltages, etc. 2500 w. Elec Rev, Lond—Sept. 16, 1910. No. 17428 A.

The Dielectric Properties of Modern High-Tension Cables. M. Höchstadter. Abstract translation from *Elektrotechnische Zeit.* Describes experiments made on paper cables at high pressures to determine the dielectric losses in the insulation. Ills. 4500 w. Elect'n, Lond—Sept. 2, 1910. No. 17080 A.

Capacity.

The Electrostatic Capacity Between Equal Parallel Wires. H. Pender and H. S. Osborne. A criticism of values given in the *General Electric Review,* showing the errors. 1500 w. Elec Wld—Sept. 22, 1910. No. 17360.

Fault Location.

An Overlap Loop Test. Daniel Shirt. Deals with a particular method of applying the Murray test, which he thinks possesses distinct advantages. 1500 w. Elect'n Lond—Aug. 26, 1910. No. 16951 A.

Insulators.

The Design and Efficiency of High-Tension Insulators. A. O. Austin. Abstract of a paper read before the Cent. Elec. Ry. Assn. Discusses types and their development, concluding that when the properties which produce reliability are fully understood, most of the troubles of transmission due to defective insulation will disappear. Ills. 2000 w. Elec Ry Jour—Sept. 24, 1910. No. 17390.

Discussion on "The Application of Porcelain to Strain Insulators" and "Electric Railway Catenary Construction," New York, May 27, 1910. Discussions on papers by W. H. Kempton, and by W. N. Smith. 10000 w. Pro Am Inst of Elec Engrs—Sept., 1910. No. 17344 F.

Line Design.

Transmission Line Calculations. Alfred Still. Discusses the inductance of electric transmission lines as effected by the subdivision of the circuits and the arrangement of the conductors. 1500 w. Elec Wld—Sept. 15, 1910. No. 17137.

Tension and Sag in High-Voltage Lines (Spannung und Durchhang in Starkstromleitungen). F. Schauer. A discussion of the regulations of the Verband Deutscher Elektrotechniker. Ills. 2500 w. Elek Kraft u Bahnen—Aug. 24, 1910. No. 17482 D.

The Influence of the Diversity Factor on Transmission-Line Design (Der Einfluss des Verschiedenheitsfaktors auf die Dimensionierung elektrischer Leitungen). Carl Richter. Mathematical. Ills. 1500 w. Elektrotech u Maschinenbau—Aug. 14, 1910. No. 17484 D.

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Poles.

Telephone Poles and Pole Lines. F. L. Rhodes. Abstract of paper read before the N. Eng. Tel. Soc. Discusses pole timbers, pole specifications, concrete poles, preservation, cross-arms, insulator pins and live wire. 3500 w. Elec Rev, N Y—Sept. 17, 1910. No. 17171.

Towers.

Steel Transmission Towers. J. Edw. Jennings. Read before the Brooklyn Engrs. Club. General description of the industry of steel transmission towers, used to support high tension electric lines. Ills. 4000 w. Can Engr—Sept. 22, 1910. No. 17411.

Transformers.

The Dimensioning of Three-Phase Transformers (Die Dimensionierung von Drehstromtransformatoren). Karl Metzler. Mathematical discussion of their design and calculation. Ills. 3000 w. Elektrotech u Maschinenbau—Aug. 28, 1910. No. 17448 D.

Voltage Regulation.

Voltage Regulation. Discusses the importance of voltage regulation, considering the regulation of the bus-bar pressure and the boosting of continuous-current feeders; also alternating-current feeder regulators, discussing types. 3500 w. Engr, Lond—Sept. 2, 1910. No. 17097 A.

Wires.

Notes on Conductors for Heavy Alternating Currents. K. C. Randall. 1500 w. Elec Jour—Sept., 1910. No. 16824.

MISCELLANY.

Copper.

The Temperature Coefficient of Resistance of Copper. J. H. Dellinger. Brief account of experimental investigations showing that the temperature coefficient was substantially proportional to the conductivity. 1000 w. Jour Fr Inst—Sept., 1910. No. 17337 D.

Electric Clocks.

Electric Clocks (L'Horlogerie électrique). M. Béache. A description of the methods and apparatus of electrical transmission of time signals. Ills. Serial. 1st part. 4000 w. Génie Civil—Aug. 6, 1910. No. 17233 D.

Insulating Materials.

The Invention of "Protal." Dr. F. G. Wiechmann. Abstract of a paper read before the Am. Inst. of Chem. Engrs. Describes a new product which can be used where rubber and similar materials are now employed. 4500 w. Sci Am Sup—Sept. 10, 1910. No. 17024.

INDUSTRIAL ECONOMY.

Accounting.

Monthly Profit and Loss Determination in Manufacturing Plants (Monatliche Gewinn- und Verlustabrechnungen). E. Blum. Discusses the method of determining profit and loss. 1700 w. Tech u Wirt—Aug., 1910. No. 17501 D.

Arbitration.

The Story of an Arbitration. Clarence Deming. An account of the arbitration in Connecticut between the street railway corporation of the state and its conductors and motormen. 3000 w. Ry Age Gaz—Sept. 16, 1910. No. 17133.

Cost Systems.

Cost Keeping in Small Factories. Paul R. Powell. Explains a system of giving exact information adequate for a moderate sized plant. 1500 w. Engineering Magazine—Oct., 1910. No. 17548 B.

The Distribution of Foundry Costs (Arbeitszeit- und Ausführungsverteilung im Giessereiwesen). W. Heym. A detailed discussion of cost systems for foundries. Ills. Serial. 1st part. 1200 w. Giesserei-Zeit—Aug. 1, 1910. No. 17273 D.

See also Management, under INDUSTRIAL ECONOMY.

Education.

The Relation of Science to Industry and Commerce. R. Blair. Read before the Educational Sci. Sec. of the British Assn., at Sheffield. Considers chiefly the relation which exists between the scientific and technical education provided at higher institutions in England, and the after careers of students. 14000 w. Nature—Sept. 15, 1910. No. 17378 A.

Theory and Practice. Arthur Bowes. Read at Manchester, Eng., before the Inst. of Munic. Engrs. Remarks on the value of each and the wisdom of their combination. 2500 w. Surveyor—Aug. 26, 1910. No. 16954 A.

The Distinction Between the Liberal and the Technical in Education. Percy Hughes. Discusses these two tendencies of modern education, the causes of seeming opposition, the influences that have affected education, the evils and causes and their remedy. 3000 w. Pop Sci M—Oct., 1910. No. 17581 C.

Discussion on "Education for Leadership in Electrical Engineering," New York, April 15, 1910. Samuel Sheldon's paper is discussed. 4500 w. Pro Am Inst of Elec Engrs—Sept., 1910. No. 17342 F.

The Mining School at Bochum, Westphalia. Prof. Henry Louis. Read before the Inst. of Min. Engrs. A descriptive account of this well-known mining school. 3500 w. Ir & Coal Trds Rev—Sept. 16, 1910. No. 17445 A.

Training Engineers at Franklin Union. F. L. Johnson. Illustrated description

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of laboratory equipment and outline of courses. 3000 w. Power—Sept. 6, 1910. No. 16932.

Exhibitions.

The Technology of Exhibitions (Zur Technik des Ausstellungswesens). J. Kollmann. Draws conclusions on planning and management from the Brussels exposition. 6500 w. Tech u Wirt—Aug., 1910. No. 17500 D.

The Buenos Ayres Exhibition. First of a series of articles describing this International exhibition and exhibits, and giving trade statistics. 2500 w. Engr, Lond—Aug. 26, 1910. Serial. 1st part. No. 16968 A.

The Brussels International Exhibition. J. O. Newman. An illustrated review of the engineering exhibits. 4500 w. Cassier's Mag—Sept., 1910. No. 17161 B.

The Destruction of the Brussels Exposition. Illustrations suggesting its extent, with explanatory comment. 250 w. Engineering Magazine—Oct., 1910. No. 17549 B.

Inventions.

The Modern Profession of Inventing. Joseph B. Baker. Remarks on the passing of the solitary inventor and the appearance of organized professional and team work. 2500 w. Am Mach—Vol. 33. No. 36. No. 17036.

Labor.

Organized Labor's Attitude Toward Machinery. Paul Klapper. A study of trade unions' attitude toward the introduction of new mechanical devices and improvements. 5000 w. Jour of Acc—Sept., 1910—Serial. 1st part. No. 17139 C.

Labor Insurance.

A New Benefit and Pension System. Explains Cheney Brothers' plan for the insurance of employees against sickness, accident and the disability of old age. 1500 w. Ir Age—Sept. 1, 1910. No. 16833 C.

Private Labor-Insurance Companies in Germany (Zur Pensionsversicherung der Privatbeamten). W. Hellmich. Discusses private enterprise in labor pensions and insurance in Germany. 2500 w. Tech u Wirt—Aug., 1910. No. 17502 D.

Management.

Systematic Foundry Operation and Foundry Costs. C. E. Knoeppel. This first of a series of articles discusses the two great forces involved in manufacturing. 3000 w. Engineering Magazine—Oct., 1910. Serial. 1st part. No. 17551 B.

The Twelve Principles of Efficiency. Harrington Emerson. This fifth article of a series discusses the third principle—competent counsel. 2500 w. Engineering Magazine—Oct., 1910. No. 17553 B.

How a Foreman Can Promote Shop Efficiency. Articles submitted in the competition on this subject. Deals principally with handling locomotives at terminals, the value of harmony among workers, and the need of keeping up-to-date in regard to methods. 5500 w. Ry Age Gaz—Sept. 2, 1910. No. 16862.

Natural Resources.

Address before the National Conservation Congress. William H. Taft. Discusses what has been done in respect to agricultural, mineral, forest, coal, oil and gas, and phosphate lands, the laws governing them, and changes proposed. 10000 w. Pop Sci M—Oct., 1910. No. 17580 C.

Patents.

Improvements in Patented Inventions. Editorial discussion of what constitutes an improvement, and to whom the improvement belongs. 1500 w. Engng—Sept. 2, 1910. No. 17094 A.

Invention and Design in Relation to Patents. Editorial discussion of complications in the patent situation. 3000 w. Eng News—Sept. 1, 1910. No. 16851.

The Status of Process Inventions. E. D. Sewall. Discusses the prejudice against process patents, giving opinions in England and the United States, and explaining the philosophy of process inventions. 6500 w. Mach, N Y—Sept., 1910. No. 16804 C.

Wage Systems.

Economy of the Piece Work System in Handling Supplies. D. C. Curtis. Brief general discussion of the piece work system, and of its application to the handling of supplies. 2500 w. Pro St Louis Ry Club—Aug. 12, 1910. No. 16853.

MARINE AND NAVAL ENGINEERING.

Barges.

Barges and Their Resistance to Traction (Matériel de la Batellerie et Essais de Résistance à la Traction). Ch. Lavaud. A study of French canal boats, with results of resistance tests. Ills. 1300 w. Mem Soc Ing Civ de France—July, 1910. No. 17200 G.

See also Motor Barges, under MARINE AND NAVAL ENGINEERING.

Battleships.

Battleship Design. Editorial discussion, giving a description of H. M. battleship Neptune. Ills. 2000 w. Engng—Aug. 26, 1910. No. 16964 A.

The United States Battleship North Dakota. Illustrations and descriptions taken from a lecture by C. B. Edwards. 300 w. Jour Am Soc of Mech Engrs—Oct., 1910 No. 17584 F.

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Electric Power.

The Present Day Problem of Ship Propulsion. L. McNamee. Examines the special features of a scheme for applying electricity to the propulsion of naval vessels—the Emmet drive. Ills. 2000 w. Pro U S Nav Inst—Sept., 1910. No. 17322 F.

See also Submarines, under MARINE AND NAVAL ENGINEERING.

Gas Engines.

Gas Driven Ships. An account of a gas power tug and it's service on the River Rhine. Ills. 1200 w. Sci Am Sup—Sept. 10, 1910. No. 17021.

Motor Barges.

Motor Barges of the Chesapeake Bay. Stuart Stevens Scott. Illustrates and describes large gasoline boats used for commerce. 2000 w. Marine Rev—Sept., 1910. No. 17128.

Motor Boats.

Large, Sea-Going Motor Yachts (Grosse, seegende Motor-Jachten). Discusses a project for a 100-ton vessel. Ills. 3000 w. Zeitschr d Mit Motorwagen Ver—Aug. 15, 1910. No. 17458 D.

Sailing Vessels.

Old Transatlantic Packet Ships. Francis B. C. Bradlee. Historical review of early transatlantic service, illustrating and describing vessels used from 1835 to 1854. 3000 w. Int Marine Engng—Sept., 1910. No. 16919 C.

Shipbuilding.

The New Regulations of the German Lloyd (Die neuen Bauvorschriften des Germanischen Lloyd). W. Matthaei. An abstract of the new regulations with discussion. 4000 w. Schiffbau—Aug. 24, 1910. No. 17289 D.

Ship Power.

On the Powering of Ships. Sidney Grover Koon. Gives tabulated data and a study of the important points entering into the powering of large ships. 3000 w. Int Marine Engng—Sept., 1910. No. 16917 C.

Ship Resistance.

The Influence of Trim Upon Resistance of Ships. D. W. Taylor. Briefly discusses the reasons why naval achitects regard moderate variations of trim as having little effect upon resistance, and reviews critically a recent paper on "Wasted Horsepower and Economical Trim." 4800 w. Pro U S Nav Inst—Sept., 1910. No. 17321 F.

The Resistance of Power Boats and a Method of Measuring Same. Seth G. Malby. Considers first resistance in general as applied to ships; second, resistance as applied to power boats; and third a method of measuring same. Ills. 5000 w. Rudder—Sept., 1910. Serial. 1st part. No. 16912 C.

See also Barges, under MARINE AND NAVAL ENGINEERING.

Ships' Boats.

The Boat Problem. Sidney F. Walker. Discusses boats required for men-of-war, and for both passenger and cargo vessels of the mercantile marine. 3000 w. Int Marine Engng—Sept., 1910. No. 16916 C.

Ship Stability.

Stability Models and Tables. Arthur R. Liddell. Discusses methods of illustrating the righting tendency of a vessel when careened under various conditions of draught and stowage. Ills. 2500 w. Engr, Lond—Aug. 26, 1910. No. 16969 A.

Ship Turning.

The Turning Power of Ships (Zur Theorie der Drehkreisbestimmung von Schiffen). Herr Rothe. Mathematical. Ills. 4500 w. Schiffbau—Aug. 10, 1910. No. 17288 D.

Ship Windows.

Scuttles and Sliding Windows for Ships. Illustrates and describes new designs. 1200 w. Engng—Aug. 26, 1910. No. 16967 A.

Steamboats.

The Passing of the Paddle Steamer. Remarks on the effect of the Parsons turbine, and reviewing some of the more famous vessels and their service. 1500 w. Engr, Lond—Sept. 16, 1910. No. 17440 A.

A New Lake Passenger Steamer. Illustrated detailed description of the new steel steamer Alabama, for service on the Great Lakes. 1700 w. Int Marine Engng—Sept., 1910. No. 16918 C.

The New Steamers of the Hamburg Steamboat Company (Die neuen Dampfer der H. D. A. G., Hamburg). Carl Fischer and Willy Sievert. Brief description. Ills. 1000 w. Schiffbau—Aug. 24, 1910. No. 17290 D.

Steam Boilers.

Marine Boiler Construction. John Green. Considers particularly the wet-bottomed cylindrical boiler with return tubes, made for pressures up to 225 pounds per square inch, and gives synopsis of boiler-construction regulations. 5000 w. Boiler Maker—Sept., 1910. No. 17070.

Steamships.

Mine-Laying and Torpedo Regulation Vessel for Portugal. Illustrated description of a small twin-screw steamer designed for laying submarine mines and testing and regulating Whitehead torpedoes. 4000 w. Engng—Sept. 9, 1910. No. 17304 A.

The Channel Steamers "Jan Breydel" and "Pieter de Coninck" in the Ostend-Dover Service (Les Paquebots "Jan Breydel" and "Pieter de Coninck" de la Ligne Ostende-Douvres). Brief description, with plate. Ills. 1600 w. Génie Civil—Aug. 6, 1910. No. 17232 D.

Steam Turbines.

The Impulse and Reaction Turbine for Marine Purposes. J. C. Shaw. A contribution to the discussion of the turbines

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in the U. S. scout cruisers, Salem and Chester, and their performance. 1000 w. Engr, Lond—Sept. 2, 1910. No. 17095 A.

Late Developments in Steam-Turbine Marine Propulsion (Die Weiterentwickelung des Dampfturbinenbaues für Schiffsantriebswecke). C. Schaffrau. Discusses recently developed transmission systems, etc. Ills. 3800 w. Schiffbau—July 27, 1910. No. 16595 D.

See also Steamboats, under MARINE AND NAVAL ENGINEERING.

Submarines.

The New United States Submarine Boat "Salmon." Waldon Fawcett. Illustrated article describing the electrical equipment. 1200 w. Elec Rev, N Y—Sept. 17, 1910. No. 17169.

The Electrical Propulsion of French Submarines. J. Breguet. Abstract translation from *La Lumière Electrique*. Notes on the electrical equipment of the latest French submarines, showing conditions and difficulties. 3000 w. Elect'n, Lond—Aug. 26, 1910. No. 16946 A.

French Submarines and Submersibles. Abstract translation of an article by M. Laubeuf, in the *Bul. of la Soc. des Ing. Civ de France*, discussing the present position of the construction of submarines and submersibles, particularly in France. 1500 w. Engr, Lond—Aug. 26, 1910. No. 16971 A.

Stability and Strength in Submarine Design (Stabilität und Festigkeit für ein Unterseeboot-Rohprojekt). K. Dietze. Discusses these factors in the design of submarines. Ills. 2000 w. Schiffbau—July 13, 1910. No. 16594 D.

Torpedoes.

The Aerial Torpedo. Johannes Engel. Reviews earlier aerial devices for carrying explosives, and gives an illustrated description of Unge's aerial torpedoes. 1600 w. Sci Am Sup—Oct. 1, 1910. No. 17539.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Brakes.

Modern Motor Car Brakes. F. E. Watts. Discusses what they should do. 1200 w. Horseless Age—Sept. 21, 1910. Serial. 1st part. No. 17415.

Cabs.

Changes in the Berlin Cab Ordinances (Aenderung der Berliner Droschkenordnung). Gives the text of the new regulations. 5000 w. Zeitschr d Mit Motorwagen Ver—Aug. 31, 1910. No. 17460 D.

Cadillac.

The 1911 Cadillac. Illustrates and describes changes and improvements introduced. 1200 w. Auto Jour—Sept. 17, 1910. No. 17418 A.

Carburetors.

Recent Tendencies in Carburetor Construction. Albert L. Clough. Discusses what is being done to adapt carburetors to the changes in the character of gasoline available and to render them more efficient generally. 2000 w. Horseless Age—Aug. 31, 1910. No. 16895.

Carbureters vs. Steam Boilers. Discusses relations of carbureters to internal combustion motors; how they take the place of steam boilers. Ills. 2000 w. Automobile—Sept. 1, 1910. No. 16889.

Kerosene Carburetors. George M. Holley. Illustrates and describes a new design, explaining principles involved. 2000 w. Horseless Age—Sept. 28, 1910. No. 17566.

G. & A. Carbureter. Illustrated description of an automatic French design based on the principle of the Venturi tube. 2000 w. Automobile—Sept. 22, 1910. No. 17382.

Kingston Carbureter. Illustrated detailed description, explaining the requirements and methods of satisfying them. 2800 w. Automobile—Sept. 22, 1910. No. 17381.

Columbia.

Columbia Is Ready. Illustrated description of "Mark 85," one of the latest models. 1800 w. Automobile—Sept. 1, 1910. No. 16888.

Commercial Vehicles.

Commercial Applications. Samuel Woods. Illustrates and describes types of power vehicles for service of a large New York department store. Also the garage. 1500 w. Horseless Age—Sept. 14, 1910. No. 17144.

Left-Side Control for Commercial Vehicles. Morris A. Hall. Discusses the mechanical and operative advantages from the location of the driver's position on the passing side of a machine. 3000 w. Com Veh—Sept., 1910. Serial. 1st part. No. 16868 C.

Motor Trucks for Foundries (Verwendung von Motorlastwagen im Giessereigewerbe). Th. Wolff. Discusses their applications and economy. Serial. 1st part. 1500 w. Giesserei-Zeit—Aug. 15, 1910. No. 17274 D.

Construction.

Some Examples of Present Steel Work in Automobile Construction. J. Coapman. Illustrates and describes a number of adaptations. 1000 w. Horseless Age—Sept. 28, 1910. No. 17567.

Control.

Uniformity of Control. An illustrated discussion of improvements desirable. 1500 w. Auto Jour—Aug. 27, 1910. No. 16940 A.

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Garages.

Inexpensive Portable Garage. Describes a fireproof garage that need not cost over $35. Ills. 1500 w. Automobile—Sept. 8, 1910. No. 17008.

Ignition.

Good Service from Dry Cells. James S. Madison. Explains how a satisfactory ignition system may be provided without a magneto. 1700 w. Automobile—Sept. 8, 1910. No. 17009.

Mercedes.

The Mercedes "Fifteen." Views and description of special details in the construction. 1200 w. Auto Jour—Sept. 10, 1910. No. 17186 A.

Motor Lubrication.

New Ideas in Motor Lubrication. C. S. Pelton. Describes a filter to be used with any splash or circulating system. Ills. 1200 w. Horseless Age—Sept. 28, 1910. No. 17568.

Motors.

Automobile Engine Proportions. A. G. Kessler and G. W. Lewis. First of a series of four articles based on the average practice of the best manufacturers in the United States. 4500 w. Am Mach—Vol. 33. No. 37. Serial. 1st part. No. 17117.

The 17-H. P. Mandslay Engine. Illustrated description of the engine and chassis. 700 w. Auto Jour—Sept. 3, 1910. No. 17074 A.

Motor Stroke.

A Résumé of the Long and Short Stroke Discussion. Albert L. Clough. Opinions and statistics showing the trend in practice in the United States during the past four years. 3000 w. Horseless Age—Sept. 21, 1910. No. 17414.

Long Stroke vs. Short Stroke Motor. Henri Feron. Trans. from *La Locomotive*. Shows that the proportion of stroke to bore should be governed by the size of the motor and the service for which it is intended. 2000 w. Horseless Age—Aug. 31, 1910. No. 16894.

Motor Testing.

A Dynamometric Brake for High-Speed Motor Testing (Sopra un Freno dinamometrico per Motori veloci). G. Cicali. Describes a device adapted to the testing of automobile motors. Ills. 1500 w. Industria—Aug. 14, 1910. No. 17243 D.

See also Dynamometers, under MEASUREMENT.

Noises.

Silence. Considers points of construction which prevent the entire absence of noise. 1800 w. Autocar—Aug. 27, 1910. No. 16939 A.

Overland.

Overlands for 1911. Illustrates and describes new models and improvements. 4500 w. Automobile—Sept. 22, 1910. No. 17383.

Racing Cars.

Modern Racing Car Construction. Illustrates and describes the Benz "Prince Henry" model. 800 w. Auto Jour—Aug. 27, 1910. No. 16941 A.

Speedometers.

The "A. T." Illustrated description of an accurate magnetic speedometer. 1000 w. Auto Jour—Sept. 17, 1910. No. 17419 A.

Standardization.

Standardization. Robert W. A. Brewer and F. G. Woollard. Notes on details that could well be standardized to the advantage of manufacturers and users. 1700 w. Autocar—Sept. 3, 1910. No. 17073 A.

Stoddard-Dayton.

Stoddard-Dayton for 1911. Calls attention to improvements introduced and illustrates and describes models. 2500 w. Automobile—Sept. 15, 1910. No. 17121.

Tires.

A Day with the Tire Makers. An illustrated review of the interesting processes, from the gathering of materials to the testing of the finished tires. 2200 w. Automobile—Sept. 15, 1910. No. 17120.

The Pros and Cons of Re-treading. Discusses when it is worth while to have tires re-treaded, and the kinds of injury liable to occur. Ills. 1800 w. Auto Jour—Sept. 17, 1910. No. 17417 A.

Transmissions.

Power Transmission Between Motor and Wheel (Die Bewegungsübertragung vom Motor auf die Automobilräder). Julius Küster. A discussion of various types of automobile transmissions. Ills. Serial. 1st part. 2200 w. Zeitschr d Mit Motorwagen Ver—Aug. 15, 1910. No. 17459 D.

COMBUSTION MOTORS.

Gas Engine Failures.

The Failure of Gas Engine Crank Shafts. Michael Longridge. Illustrated report on the large number of failures due to weakness of this part. 2000 w. Mech Engr—Sept. 2, 1910. No. 17085 A.

Gas Engine Operation.

Recent Experiences in Working Large Gas Engines. Prof. Langer. Abstract of paper read before the Düsseldorf Cong. Gives diagram showing the relative development in Europe of 2-cycle and 4-cycle gas engines, and discusses defects of construction and difficulties experienced. Ills. 2000 w. Ir & Coal Trds Rev—Aug. 26, 1910. No. 16988 A.

Gas Engines.

Notes on the Constructional Details of Gas Engines. Mathematical. 1200 w. Mech Wld—Sept. 16, 1910. Serial. 1st part. No. 17426 A.

The Explosive Properties of Gaseous Mixtures. (Las Mezclas gaseosas detonantes consideradas como Explosivos). Carlos Barutell. A discussion of the phenomena of explosion in gas-engine cylinders. 2500 w. Energia Elec—Aug. 10, 1910. No. 17249 D.

Gaseous Explosions. Third report of the committee appointed for the investiga-

tion of gaseous explosions, with special reference to temperature, presented before the Engng. Soc. of the British Assn. for the Adv. of Science. 6000 w. Mech Engr—Sept. 9, 1910. Serial. 1st part. No. 17191 A.

Air-Supply to Gas-Engines. W. E. Dalby. Read before Sec. G. of the British Assn. Experimental study describing method of direct measurement of the air supply by means of an orifice and the calibration of the orifice. 2500 w. Engng—Sept. 9, 1910. No. 17308 A.

Gas Engines for Driving Alternating-Current Generators. Discussion of H. G. Reists' paper. 900 w. Jour Am Soc of Mech Engrs—Sept., 1910. No. 16817 F.

Gas-Engine Generating Sets (Groupes électrogenes avec Moteur à Gaz pauvre). J. A. Montpellier. Describes the Cazes high-speed gas engine and producer for small generating units. Ills. 1500 w. L'Elecn—Aug. 13, 1910. No. 17226 D.

See also same title, under MARINE AND NAVAL ENGINEERING.

Gas Engine Troubles.

Knocking in Gas Engines. Hints which may help in the location and remedy of such troubles. 1200 w. Mech Wld—Sept. 16, 1910. No. 17425 A.

Gasoline Engines.

See Motor Cars, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Gas Power Plants.

Operating Experiences with a Blast Furnace Gas Power Plant. Discussion of Heinrich J. Freyn's paper. Also appendix 6, an addition to this paper. Ills. 12000 w. Jour Am Soc of Mech Engrs—Sept., 1910. No. 16820 F.

The Modern Producer Gas Engine Plant. D. D. Faris. Discusses some of the recent developments and future possiblities of such plants. Also general discussion. 5500 w. So & S W Ry Club—July, 1910. No. 17324 D.

Utilizing Waste Heat from Gas Engine Plants. John T. Faig. Abstract of a paper read before the Nat. Gas and Gasoline Engine Trades Assn. Brief suggestions for the utilization of jacket-water and exhaust gases. Ills. 1000 w. Mech Engr—Sept. 9, 1910. No. 17190 A.

Gas Turbine Governing.

The Governing of Gas Turbines (Ueber die Regelung der Gasturbinen). W. Gentsch. The first part of the serial discusses the operation of the gas turbine. Ills. Serial. 1st part. 1000 w. Die Turbine—Aug. 5, 1910. No. 17299 D.

Oil Engines.

The Diesel Oil Engine for Marine Work. Peter Stobie. Read before the Greenock Assn. of Engrs. & Shipbuilders. Describes applications of the Diesel engines and the types used. 2000 w. Mech Wld—Aug. 26, 1910. No. 16958 A.

Fuel Injecting Apparatus for Internal Combustion Engines. Illustrates and describes a design of fuel-injecting apparatus for two-cycle internal combustion engines of the Diesel type. 800 w. Mech Engr—Sept. 16, 1910. No. 17423 A.

HEATING AND COOLING.

Air Cooling.

Cooling Buildings by a New Method of Construction. Illustrated detailed description of the method known as the Fellowes system. 1000 w. Heat & Vent Mag—Sept., 1910. No. 17328.

Air Filtration.

The Richet Air Filter (L'Aérofiltre Richet). A Moreau. Brief illustrated description. 1200 w. Bul Soc d'Encour—July, 1910. No. 17214 G.

Refrigeration.

Elements of Compression System. F. E. Matthews. Illustrated explanation of the principles of operation of this and other systems. 3200 w. Power—Sept. 6, 1910. No. 16935.

Operation of Compression System. F. E. Matthews. Explains the cycle of operation. Ills. 1500 w. Power—Sept. 20, 1910. No. 17318.

Boston Terminal Refrigerating Company's Plant. Illustrated description of the new cold storage warehouse. 1200 w. Ice & Refrig—Sept., 1910. No. 16930 C.

A New Ice Factory in Chicago. General description and views of a 150-ton ice-making plant. 1500 w. Ice & Refrig—Sept., 1910. No. 16931 C.

Leblanc New Refrigerating Process. Illustrated description of a new machine adopted by the French Navy. 1400 w. Sci Am Sup—Oct. 1, 1910. No. 17538.

Steam Heating.

Gravity Steam Heating of a Hospital. Charles L. Hubbard. Heating and ventilating cottage hospitals and the preparation of the apparatus. 1600 w. Met Work—Sept. 17, 1910. No. 17142.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

Design of Centrifugal Pumps. A. Borsody. Influence of the design of the impeller upon the general characteristics, giving formulas and rules to aid the designer. Ills. 200 w. Am Mach—Vol. 33. No. 38. Serial. 1st part. No. 17394.

Turbine Pump Characteristics. Frederick Ray. An illustrated explanation and discussion of the relations of head, power and efficiency to the output of a turbine pump. 4000 w. Am Mach—Vol. 33. No. 36. No. 17034.

Twinvolute Turbine Pumps. Illustrates and describes types suitable for all kinds of service. 1800 w. Ir Age—Sept. 22, 1910. No. 17356.

Electric Pumping.

Automatic Starting and Regulating Devices for Pump and Compressor Motors

We supply copies of these articles. See page 327.

(Ueber selbsttätige Anlass- und Regulierorrichtungen für Pumpen- und Kompressormotoren). Ludwig Weil. Describes their theory and various types. Ills. Serial. 1st part. 2700 w. Elektrotech u Maschinenbau—Aug. 21, 1910. No. 17487 D.

Gas Pump.

The Humphrey Internal Combustion Pump. Illustrated description of an interesting exhibit at the Brussels Exposition. 1700 w. Ir Age—Sept. 15, 1910. No. 17130.

Presses.

See Packings, under MATERIALS OF CONSTRUCTION.

Pumping Plants.

Pumping Plant for the Trustees of the Bombay Port Trust. Plate and description of the plant to be used for pumping out the Hughes Dry Dock. 800 w. Engng—Sept. 16, 1910. No. 17437 A.

See also Water Towers, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

Pumps.

See Engines, under STEAM ENGINEERING.

Pump Valves.

A New Pump Valve (Una nuova Valvola per Pompe). H. Rissmann. Describes the new valve of the Balcke Machine Company, Bochum. Ills. Serial. 1st part. 1300 w. Industria—Aug. 28, 1910. No. 17244 D.

Turbine Tests.

An Investigation of Pressure Distribution in Reaction-Turbine Buckets (Versuche über die Druckverteilung in den Laufzellen arbeitender Reaktionsturbinen). A. Pfarr. Detailed data of the tests and results. Ills. Serial. 1st part. 3800 w. Zeitschr d Ver Deutscher Ing—Aug. 27, 1910. No. 17499 D.

Turbine Theory.

The Fundamentals of Turbine Theory. (Die Grundlagen der Turbinentheorie). Georg Popper. Mathematical discussion of hydraulic-turbine theory. 2700 w. Zeitschr f d Gesamte Turbinenwesen—Aug. 20, 1910. No. 17451 D.

MACHINE ELEMENTS AND DESIGN.

Clutches.

Experimental Analysis of a Friction Clutch Coupling. Discussion of William T. Magruder's paper. 1700 w. Jour Am Soc of Mech Engrs—Oct., 1910. No. 17587 F.

Connecting Rods.

A Graphical Method for Calculating Stresses in a Connecting Rod. Winslow H. Herschel. Explains method and gives examples of its application. 5000 w. Jour Am Soc of Mech Engrs—Oct., 1910. No. 17585 F.

Cylinders.

The Strength of Guns and Cylinders. C. A. M. Smith. Report of experimental investigations of "Guest's law," showing that certain conditions are followed by certain results. 1800 w. Engng—Sept. 2, 1910. No. 17092 A.

Gears.

Allowable Load and Efficiency of Worm Gearing. A. P. Eltoft. Discusses the relation of load to effort, allowable load, and gives an example illustrating the use of formulas given. Ills. 2500 w. Mach, N Y—Sept., 1910. No. 16811 C.

Direct Solution of Spiral Gear Angles. J. Butterworth. Gives tables that will assist in a direct solution of spiral gear angles, given a fixed center distance and normal pitch. 1000 w. Am Mach—Vol. 33. No. 36. No. 17031.

Influence of Impact on Gears. Charles H. Logue. A suggested modification in the Barth equation as applied to the Lewis formula for the strength of gears. 800 w. Am Mach—Vol. 33. No. 38. No. 17393.

Punch Frames.

The Strength of Cast Iron Punch and Riveter Frames. Discussion of A. L. Jenkins' paper. 6000 w. Jour Am Soc of Mech Engrs—Sept., 1910. No. 16816 F.

Rotating Drums.

The Calculation of Rotating Drums (Die Berechnung rotierender Trommeln). Rudolf Lorenz. An exhaustive mathematical discussion. Ills. 4500 w. Zeitschr d Ver Deutscher Ing—Aug. 20, 1910. No. 17498 D.

MACHINE WORKS AND FOUNDRIES.

Aluminium Founding.

See Cores, under MACHINE WORKS AND FOUNDRIES.

Annealing.

The Annealing of Steel. C. M. Johnson. Discusses why steel is annealed and the results obtained. 2500 w. Am Mach—Vol. 33. No. 38. No. 17395.

Brass Founding.

Molding Brass Axle Bearings for Electric Cars. C. Vickers. Illustrated description of method used in Milwaukee, Wis. 1800 w. Foundry—Sept., 1910. No. 16814.

Finishing and Plating Brass Castings. C. Vickers. Illustrates and describes methods used by the National Cash Register Co. 3500 w. Foundry—Sept., 1910. No. 16813.

The Brass Scrap Pile. Suggestions for judging scrap, testing, etc. 2000 w. Foundry—Sept., 1910. Serial. 1st part. No. 16815.

Case Hardening.

Case Hardening in Vacuum with Pure Carbon (Ueber Zementation im luftleeren Raum mittels reinen Kohlenstoffes). Fritz Weyl. Abstract of a paper read at the Düsseldorf Congress. Describes the method and apparatus and reports results. Ills. 1500 w. Stahl u Eisen—Aug. 17, 1910. No. 17262 D.

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Castings.

Chilled Castings (Hartguss). Bernhard Osann. Discusses the methods and difficulties of their production, the nature of the changes produced by chilling, etc. Ills. 2100 w. Stahl u Eisen—Aug. 10, 1910. No. 17256 D.

Cores.

Cores for Aluminum Castings. Walter J. May. Remarks on the trouble with shrinkage in aluminum castings, and report of methods tried by the writer and his success with paper cores. Ills. 1500 w. Mech Wld—Sept. 9, 1910. No. 17192 A.

Past and Present Core Supports (Die Kernstützen in früherer und neuerer Zeit). H. Vetter. A review of progress in this branch of foundry practice. Ills. 2500 w. Stahl u Eisen—Aug. 10, 1910. No. 17258 D.

Cutting Tools.

Economical Tool Dressing and Grinding. John Brandle. Explains correct methods of tool dressing, resulting in economy. 1800 w. Mach, N Y—Sept., 1910. No. 16807 C.

Internal Cutting Tools. Douglas T. Hamilton. Information concerning practice for the Brown & Sharpe automatic screw machine. Ills. 4500 w. Mach, N Y—Sept., 1910. Serial. 1st part. No. 16808 C.

Dies.

Practical Hints for Diemakers. Richard L. Breul. The present number discusses blanking and piercing dies. 1500 w. Mach, N Y—Sept., 1910. Serial. 1st part. No. 16812 C.

Forging.

The Making of Drop Forgings. E. F. Lake. An illustrated discussion of materials and methods and their effects. 2200 w. Am Mach—Vol. 33. No. 38. No. 17392.

Forging Machines.

Forging Machine at the Midland Railway Carriage & Wagon Works, Derby. Illustrated detailed description of a No. 4 Horsfall patented forging machine. 500 w. Engr, Lond—Sept. 2, 1910. No. 17101 A.

Foundries.

Specialty Foundry Designed for Automobile Work. Illustrated description of a multiple-story foundry in Cleveland, O., its equipment, methods, etc. 2200 w. Castings—Sept., 1910. No. 17166.

The Foundry Plants of the R. Ph. Waagner Company, L. & J. Biro, and A. Kurz, Vienna (Die Giessereianlagen der Akt.-Geo. R Ph. Waagner, L. & J. Biro and A. Kurz in Wien). Gustav Simon. Illustrated description of interesting features of these large works. Ills. 4000 w. Stahl u Eisen—Aug. 10, 1910. No. 17255 D.

Foundry Furnaces.

The Electric Furnace. W. S. Gifford. Read before the British Found. Assn. Reviews what has been accomplished in the application of the electric furnace to the making of castings. 1200 w. Mech Engr—Aug. 26, 1910. No. 16956 A.

Foundry Practice.

The Foundry Work on Manifolds, Branch-tees or Headers. F. W. Barrows. Explains the construction of core-boxes, and discusses patternmaking and foundry practices. Ills. 2500 w. Castings—Sept., 1910. No. 17167.

Practical Hints on the Mixing of Irons for Special Castings. From *Foundry Trade Jour.* Suggestions for castings to induce superheated steam, flame and acids. 2000 w. Mech Wld—Aug. 26, 1910. No. 16957 A.

Furnaces.

A Vertical Tempering Furnace at the Arbel Works of the Donai Forges (Four à Tremper vertical des Forges de Douai). Le Ct. Fourgeot. Illustrated description of the heat-treatment plant. 2000 w. Rev de Métal—Aug., 1910. No. 17211 E + F.

Galvanizing.

The Influence of Galvanizing on the Strength of Wire. Information from a paper by Dr. Heinrich Winter, read at the Düsseldorf Congress. Explains tests made and conclusions. 1000 w. Ir Age—Sept. 1, 1910. No. 16834 C.

A New Metal-Coating Process (Un nouveau Procédé de Métallisation). M. Schoop. Describes the Schoop process of applying metallic coatings. Ills. 2500 w. Rev de Métal—Aug., 1910. No. 17210 E + F.

Gear Cutters.

The Robey-Smith Bevel Gear Planer. John M. Lloyd. Illustrated detailed description of an interesting English machine and its operation. 2500 w. Ir Age—Sept. 29, 1910. No. 17560.

Grinding Machines.

New Diamond Grinders. Illustrates and describes four improved lines of grinding and polishing machines, made at Providence, R. I. 1500 w. Ir Age—Sept. 29, 1910. No. 17562.

A Grinding Machine for Finishing the Inside and Outside Bearings of Locomotive Driving Axles (Schleipmaschinen zur Bearbeitung der Innen- und Aussen-Lagerstellen von Lokomotivradsätzen). Illustrated description. 1200 w. Glasers Ann—Aug. 15, 1910. No. 17457 D.

Jigs.

The Principles of Jig Design. R. D. Spinney. Explains the usefulness of jigs and discusses the requirements to be kept in mind in the preparation of a jig, the varieties, etc. Ills. 1500 w. Mech Wld—Sept. 9, 1910. Serial. 1st part. No. 17193 A.

Lathes.

Record Ouput of a Car Wheel Lathe. Illustration of a lathe which wound 33 pairs of 36-in. steel-tired wheels in less than 10 hours. 500 w. Am Engr & R R Jour—Sept., 1910. No. 16924 C.

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A Comparison of Lathe Headstock Characteristics. Discussion of Prof. Walter Rautenstrauch's paper. 800 w. Jour Am Soc of Mech Engrs—Oct., 1910. No. 17586 F.

Machine Tools.

Gearing for Machine Tools. Thomas R. Shaw. An illustrated analysis of the all-gear drive. 4000 w. Cassier's Mag—Sept., 1910. No. 17163 B.

Machine Tool Design. W. D. Forbes. Helpful suggestions for designers. Ills. 2000 w. Mach, N Y—Sept., 1910. No. 16805 C.

Machine Stops, Trips, and Reversing Mechanisms. Joseph G. Horner. Illustrates and describes various devices and their applications. 4000 w. Mach, N Y—Sept., 1910. No. 16802 C.

The Drummond-Barreto Universal Machine. Illustrated description of a machine for boring, turning, drilling, screw-cutting, milling and gear-cutting, shown at the Olympia exhibition. 700 w. Engng—Sept. 2, 1910. No. 17093 A.

Molding.

The "Washburne" Clay Riser Lining. Illustrated description of this riser lining and its use. 1200 w. Brass Wld—Sept., 1910. No. 17141.

See also Brass Founding, under MACHINE WORKS AND FOUNDRIES.

Pattern Making.

The Shop Practice of a Patternmaker. W. S. Giele. Deals with materials and methods used in modern practice. 7000 w. Castings—Sept., 1910. No. 17168.

Pipe Drawing.

Seamless Steel Tube Manufacture. J. F. Springer. Illustrates and describes methods, with special reference to the National Tube Co.'s processes. 3000 w. Ir Age—Sept. 15, 1910. No. 17129.

Pneumatic Tools.

Use and Care of Pneumatic Tools. Address of J. H. Simmons before the Ry. Tool Foremen's Assn. The importance of properly cleaning and lubricating them, their abuse, suggestions, etc. 1700 w. Boiler Maker—Sept., 1910. No. 17071.

Polishing.

Emery Wheels. James F. Hobart, in *Blacksmith and Wheelwright.* Describes apparatus for polishing. Directions for making the wheels, mounting, etc. 3000 w. Mech Wld—Sept. 2, 1910. No. 17088 A.

Presses.

A 600-Ton Steel Stamping Press. Illustrated description of a tool for finishing off steel motor car hubs. 800 w. Engr, Lond—Sept. 2, 1910. No. 17100 A.

Sand Blast.

The Sand Blast and Its Uses. René Champly. An illustrated account of its development and applications. 800 w. Sci Am Sup—Sept. 10, 1910. No. 17023.

The Sand Blast in Foundry Operation (Das Sandstrahlgebläse, seine Erfindung und Verwendung in der Giessereipraxis). O. Friedheim. Describes the machines built by Alfred Gutmann, Hamburg. Ills. 1600 w. Giesserei-Zeit—Aug. 15, 1910. No. 17275 D.

Sheet Metal Working.

The Manufacture of Armature-Core Discs (Die Herstellung der Anker- und Segmentbleche zu Elektromotoren und Dynamos). C. Krügener. Describes practice and machinery, particularly the apparatus manufactured by L. Schuler, Göppingen, Germany. Ills. Serial. 1st part. 700 w. Elektrotech Rundschau—Aug. 18, 1910. No. 17474 D.

Shop Appliances.

Clamps and Straps for Holding Work While Machining. H. E. Wood. Illustrations, with explanatory notes. Supplement. 1200 w. Mach, N Y—Sept., 1910. No. 16809 C.

Some Small Tools in a Railroad Shop. Illustrates and describes special tools and fixtures used in the Beech Grove shops of the Big Four R. R. 1200 w. Am Mach—Vol. 33. No. 35. No. 16839.

Shop Design.

Layout for a Small Shop. James F. Hobart. Remarks on the arrangement of machine tools, getting the light where it is most needed, etc. 2500 w. Wood Craft—Sept., 1910. No. 16886.

Shop Practice.

Reducing the Costs of Engine Building by Efficiency Methods. William O. Webber. Gives results, explaining the methods that produced them. 2000 w. Engineering Magazine—Oct., 1910. No. 17555 B.

Making Transformer Cases. Illustrates and describes apparatus and methods employed by the Gen. Elec. Co., Pittsfield, Mass. 700 w. Am Mach—Vol. 33. No. 35. No. 16837.

Milling and Drilling Operations on the Ellis Adding Typewriter. Ralph E. Flanders. Illustrates and describes shop practice at the factory in Newark, N. J. 3500 w. Mach, N Y—Sept., 1910. Serial. 1st part. No. 16806 C.

Shop Kinks. Illustrated descriptions of shop practice and appliances in various railroad shops. 7500 w. Ry Age Gaz—Sept. 2, 1910. No. 16861.

Shops.

Sirocco Engineering Works, Belfast. Illustrated description of a new foundry recently put in operation, with information concerning the Sirocco Works generally. 1500 w. Engr, Lond—Aug. 26, 1910. No. 16974 A.

See also same title, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Shop Ventilation.

The Removal of Benzine Vapors in Rubber Factories (L'Enlèvement des Vapeurs de Benzine dans les Usines de Caoutchouc). Describes various devices

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for removing fumes in industrial plants. Ills. 2500 w. Génie Civil—Aug. 20, 1910. No. 17236 D.

Spring Making.

Machine for Making Spiral Springs. Frank S. Bunker. General description of an interesting piece of apparatus. 1200 w. Am Mach—Vol. 33. No. 38. No. 17396.

Taps.

Taps and Die Stocks (Note sur les Tarauds et Filières). A. Minne. Discusses difficulties and requirements and describes a new type of tap. Ills. 1500 w. Mem Soc Ing Civ de France—July, 1910. No. 17201 G.

Tempering.

Hardening Room with New Features. E. F. Lake. Illustrated description of a hardening room at Flint, Mich., specially designed and equipped for automobile work. 2500 w. Am Mach—Vol. 33. No. 36. No. 17030.

Steel and Steel Hardening (Stahl und Stahlhärtung). Describes a number of European hardening ovens. Ills. Serial. 1st part. 2000 w. Zeitschr f Werkzeug—Aug. 5, 1910. No. 17461 D.

See also Furnaces, under MACHINE WORKS AND FOUNDRIES.

Tool Rooms.

Special Tool-Room Appliances in a Railroad Shop. Ralph E. Flanders. Illustrates and describes tools and devices used at the Juniata Shops at Altoona, Pa. 1600 w. Mach, N Y—Sept., 1910. No. 16803 C.

See also Cutting Tools, under MACHINE WORKS AND FOUNDRIES.

Welding.

Oxy-Acetylene Welding, Apparatus. E. F. Lake. Discusses the process and the inventions that make it possible, and its application. 4000 w. Am Mach—Vol. 33. No. 36. Serial. 1st part. No. 17032.

MATERIALS OF CONSTRUCTION.

Alloys.

Light Alloys for Aeronautical Purposes. W. Rosenhain. From the report of the Adv. Com. for Aeronautics for the year 1909-10. Describes and compares these alloys and states conclusions. 2500 w. Mech Engr—Sept., 1910. No. 17424 A.

Alloy Steels.

Cupro-Nickel Steel. G. H. Clamer. Extracts from a paper read at recent meeting of Am. Soc. for Test. Mat. Reviews recent work on the properties and constitution of alloys, and reports tests and conclusions. Discussion by Dr. John A. Matthews. 2500 w. Met & Chem Engng—Sept., 1910. No. 16874 C.

Vanadium and Metallurgy. J. Kent Smith and W. L. Turner. Briefly considers some of the ways in which vanadium acts upon steel, as introductory to detailed descriptions of the commercial types of vanadium steels now in use. 1500 w. Ir & Coal Trds Rev—Sept. 9, 1910. Serial. 1st part. No. 17314 A.

Breakages.

The Study of Breakages. J. C. W. Humfrey. Gives a brief account of the more frequent causes of failure, and a general description of the manner of investigating at the Nat. Phys. Laboratory, with details of a number of cases. 29 illustrations. 9500 w. Jour W of Scotland Ir & St Inst—March-April, 1910. No. 17325 N.

Cast Iron.

The Effect of Sulphur and Silicon on Cast Iron. J. E. Stead. Presidential address at Sheffield, before the British Assn. Discusses the effect of these substances on the carbon condition of commercial cast iron. Ills. 7500 w. Nature—Sept. 8, 1910. No. 17185 A.

The Relation Between the Elasticity of Cast Iron Under Bending Stress and Its Elasticity Under Tension and Compression (Zusammenhang der Biegungselastizität des Gusseisens mit seiner Zug- und Druckelastizität). A. Herbert. A report and discussion of elaborate tests. Ills. Serial. 1st part. 4400 w. Zeitschr d Ver Deutscher Ing—Aug. 20, 1910. No. 17496 D.

Heat Insulation.

Testing of Heat Insulating Materials. F. Bacon. Describes apparatus for calculating the loss of heat in heat-insulating materials, and gives particulars of tests on a number of materials, and also the effect of an air jacket. 2000 w. Elect'n, Lond—Sept. 16, 1910. No. 17430 A.

Conductivity of Heat-Insulation and Structural Materials (Wärmeleitfähigkeit von Isolier- und Baustoffen). Heinrich Gröber. Reports results of tests at the Munich Technical Highschool. 4000 w. Zeitschr d Ver Deutscher Ing—Aug. 6, 1910. No. 17491 D.

Metallography.

Apparatus for Microscopic Examination of Metals. Albert Sanveur. An illustrated discussion of the methods and equipment required in metallographical research. 3500 w. Ir Trd Rev—Sept. 8, 1910. Serial. 1st part. No. 17007.

Packings.

Packings for Hydraulic Presses. A. Lewis Jenkins. Illustrates and describes different kinds used, discussing their efficiency. 3000 w. Am Mach—Vol. 33. No. 38. No. 17397.

Steel.

The Gases Occluded in Steel (Ueber die Gase aus technischen Eisensorten). P. Goerens. Describes apparatus used in making tests and reports results. Ills. 2800 w. Stahl u Eisen—Aug. 31, 1910. No. 17270 D.

Tool Steel.

Cutting Properties of Tool Steel. Edward G. Herbert. A report of tests and

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practical information obtained from them. 3000 w. Am Mach—Vol. 33. No. 36. Serial. 1st part. No. 17035.

MEASUREMENT.

Accelerometer.

On the Use of an Accelerometer in the Measurement of Road Resistance and Horse-Power. H. E. Wimperis. Illustrates and describes the construction and principle of an accelerometer designed by the author, giving results of tests. 2000 w. Elect'n, Lond—Sept. 16, 1910. No. 17433 A.

Calipers.

Automatic Micrometer Calipers. Illustrated description of a series of automatic calipers made in England. 1500 w. Mech Engr—Aug. 26, 1910. No. 16955 A.

Calorimetry.

Determining the Heat Value of Coal (Heizwertbestimmungen von Kohlen). A. Brüser. The first part describes a bomb calorimeter devised by the author. Ills. Serial. 1st part. 1000 w. Elektrotech Rundschau—Aug. 25, 1910. No. 17476 D.

Dynamometers.

The Cradle Dynamometer for Testing Electrical Machinery. J. Davis and F. Shaw. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Illustrated description of the instrument and its use, giving experiments and results. 2000 w. Mech Engr—Sept. 2, 1910. No. 17084 A.

A. C. A.'s New Engine Testing Dynamometer. Joseph B. Baker. Illustrated description of a machine for testing automobile, motor boat, and aeroplane engines. 2200 w. Horseless Age—Sept. 14, 1910. No. 17143.

A Dynametric Plow for Determining Some Physico-Mechanical Characteristics of Earth (Di un nuovo Coltro dinamometrico per la Determinazione di alcune Caratteristiche fisico-meccaniche del Terreno). Federigo Giordano. Describes the device and its use. Ills. Serial. 1st part. 1000 w. Industria—Aug. 14, 1910. No. 17242 D.

Efficiencies.

A Comparison of Efficiencies. G. A. Glick. Defines mechanical and thermal efficiencies, and explains how they are obtained for various types of machines. 1500 w. Power—Sept. 13, 1910. No. 17056.

Gas Meters.

Measurement of Quantities of Gas by Means of Diaphragms (Mesure des Quantités de Gaz au Moyen de Diaphragmes). Otto Muller. A complete theoretical and practical discussion of the method, based on extended experiments. Ills. 10000 w. Rev de Métal—Aug., 1910. No. 17213 E + F.

Hardness

Present Position of Hardness Testing (Der Heutige Stand der Härteprufung). A Reichelt. A review of methods and apparatus. Ills. 2100 w. Giesserei-Zeit—Aug. 1, 1910. No. 17271 D.

Impact Test.

The Impact Test for Cast Iron (Ueber Schlagproben mit Gusseisen). A. Gessner. Reports results of tests and discusses the utility of impact testing. 1500 w. Stahl u Eisen—Aug. 10, 1910. No. 17257 D.

Planimeters.

An Improved Hatchet Planimeter. Frank S. Bunker. Illustrates and describes an improved form in which the plane of the tracing arm is kept constantly at right angles to the surface of the area to be measured. 1200 w. Power—Sept. 20, 1910. No. 17319.

Testing Metals.

Integrity of Tests of Metals. Alexander E. Outerbridge, Jr. Reasons for doubts as to whether such tests may be relied upon with confidence. 2000 w. Jour Fr Inst—Sept., 1910. No. 17336 D.

The Mean Value of Test Results (Der Mittelwert von Festigkeitszahlen). A. Cappilleri. A discussion of methods of obtaining the mean of the results of strength of materials tests. Ills. 3000 w. Aug. 6, 1910. No. 17467 D.

Testing Methods.

Steel Testing by Corrosion (Essais des Aciers par Corrosion). F. Cloup. Describes the value of the corrosion test devised by M. Frémont in detecting piping in steel. Ills. 2000 w. Rev de Métal—Aug., 1910. No. 17212 E + F.

Thermometry.

Thermometer Correction Curves. Frederick Ray. Gives curves showing the corrections to be added for various immersions of the thermometer stem and various temperatures. 700 w. Power—Sept. 27, 1910. No. 17511.

Water.

The Right Angled Triangular Weir. Charles N. Cross. Discusses a type of weir which has proved more satisfactory than the rectangular weir in measuring small quantities of water. 1200 w. Power—Sept. 20, 1910. No. 17320.

POWER AND TRANSMISSION.

Air Compressors.

Hydraulic Compressors (Hydraulische Kompressoren). P. Bernstein. Briefly describes installations in Europe and America. Ills. 1500 w. Glückauf—Aug. 13, 1910. No. 17282 D.

See also Engines, under STEAM ENGINEERING.

Belts.

The Determination of Pulley and Belt Sizes. C. B. Mills. Gives a chart and explains an easy graphic solution of belt problems. 2000 w. Elec Jour—Sept., 1910. No. 16826.

Compressed Air.

The Efficiency of Compressed Air. Snowden B. Redfield. Explains the ratio

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of the work represented in the compressed air to that done by the compressor. 1000 w. Power—Sept. 13, 1910. No. 17057.

The Production and Utilization of Compressed Air in Germany to the Beginning of 1910 (Die Erzeugung und Verwendung von Druckluft im deutschen Bergbau zu Beginn des Jahres 1910). A. von Ihering. A statistical review of compressed-air practice. 10200 w. Glückauf—Aug. 27, 1910. No. 17286 D.

Compressed Air Hose.

Economical Size of Air Hose. R. D. Gatewood. Explains methods of determining the best size of air hose for pneumatic tools used in a shipbuilding plant. Ills. 900 w. Am Mach—Vol. 33. No. 36. No. 17033.

Specifications for Air Hose. R. D. Gatewood. Explains methods of testing devised to govern the purchase of 50,000 feet of air hose for the Mare Island Navy Yard. 1500 w. Am Mach—Vol. 33. No. 35. No. 16840.

Critical Speeds.

Critical Speed Calculation. S. H. Weaver's paper is discussed. 1200 w. Jour Am Soc of Mech Engrs—Sept., 1910. No. 16821 F.

Electric Driving.

Power Consumption of the Machine Tools at the Readville Shops. Gives results of tests to determine the power required for driving individual and grouped machine tools under light and full load conditions. 1000 w. Am Engr & R R Jour—Sept., 1910. No. 16923 C.

Gearing.

See Machine Tools, under MACHINE WORKS AND FOUNDRIES.

Mechanical Plants.

A modern Combination Utility Plant. Illustrated description of an electric-generating, steam-heating, refrigerating and cold-storage plant at Detroit. 4000 w. Elec Wld—Sept. 1, 1910. No. 16841.

Power Plants.

Metropolitan Home Office Plant. F. L. Johnson. Illustrated description of the power plant equipment of the tallest office building in the world, and some of the leading features of the building. 2200 w. Power—Sept. 20, 1910. No. 17315.

Solar Motors.

The Commercial Solution of the Problem of Utilizing, for the Production of Power, the Energy of Solar Radiation, the Wind and Other Intermittent Natural Sources. R. A. Fessenden. Read before the British Assn. Claims to have solved this problem. Also editorial. 4500 w. Elect'n, Lond—Sept. 16, 1910. No. 17434 A.

Turbo-Compressors.

Testing the Discharge of a Turbo Blower. Michael Longridge. From report for 1909 of the British Engine, Boiler & Elec. Ins. Co., Ltd. Describes tests made as examples of two methods by which large quantities of air at absolute pressures were measured, and to show how the velocities varied. Ills. 1500 w. Mech Engr—Sept. 16, 1910. No. 17422 A.

Novel Air Compressor. Illustrated description of a new mechanical movement, shown at the British Engng. Ex., which can be applied to the motoring field.—The Lamplough rotary air compressor. 1200 w. Automobile—Sept. 29, 1910. No. 17571.

Wind Power.

See Solar Motors, under POWER AND TRANSMISSION.

STEAM ENGINEERING.

Barometric Readings.

Handy Chart for Barometer Readings. G. A. Glick. Gives chart for the conversion of barometric readings, with explanation. 400 w. Power—Sept. 6, 1910. No. 16934.

Boiler Design.

The Application of Graphical Charts to the Solution of Boiler Problems. F. A. Garrett. Explains the principles of graphical charts and their application to various boiler problems. 3000 w. Boiler Maker—Sept., 1910. No. 17069.

Boiler Fittings.

Blow-Off Cocks for Steam Boilers. Charles J. Simeon. Illustrates and describes developments in the design. 1000 w. Power—Sept. 20, 1910. No. 17317.

Boiler Management.

Care and Operation of Steam Boilers. William Westerfield. Discusses proper and improper methods of firing and their influence on combustion, giving some useful hints upon cleaning fires. 1200 w. Power—Sept. 27, 1910. No. 17509.

Boilers.

See Engines, under STEAM ENGINEERING.

Boiler Stoking.

See Smoke Prevention, under STEAM ENGINEERING.

Condensers.

Condensers for Small Central Stations. Harry Pennington. Read before the S.-W. Elec. & Gas Assn. Explains the effect of vacuum on the steam consumption of various types of prime movers, discussing condensation and describes recent improvements in condenser apparatus. Ills. 5000 w. Am Gas Lgt Jour—Sept. 5, 1910. No. 16887.

The Velocity of the Circulating Water in Surface Condensers. R. M. Neilson. Discusses the question of the velocity of the water through the condenser tubes, aiming to show the limits within which the best velocity may be ascertained in any given case. 3000 w. Engr, Lond—Sept. 9, 1910. No. 17311 A.

Automatic Control of Condensing Water. B. Viola. Deals chiefly with con-

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densers for vacuum plants, explaining conditions and describing the construction of the automatic controller. Ills. 2500 w. Jour Am Soc of Mech Engrs—Oct., 1910. No. 17583 F.

Some Experiments with the Regulation of Circulating Water. W. N. Y. King. Describes experiments with circulating water for condensers, giving tabulated results. 800 w. Elec Rev, Lond—Sept. 2, 1910. No. 17077 A.

Engine Compression.

Some Points Favoring Compression. Prof. R. C. Heck. Objects to conclusions unfavorable to compression in an article by Prof. Dwelshauvers-Dery, and claims that compression properly applied is advantageous. Ills. 2500 w. Power—Sept. 13, 1910. No. 17507.

Clearance and Compression. V. Dwelshauvers-Dery. A reply to Prof. Heck's criticism of the author's earlier paper, giving facts which he claims invalidates Prof. Heck's argument. 2800 w. Power—Sept. 27, 1910. No. 17514.

Engine Design.

High Speed Compound Engine Design. J. D. Speedium. First of a series of articles giving illustrated detailed description of present British practice in the design of a 500-h.p. engine. 4000 w. Power—Sept. 27, 1910. No. 17512.

Engine Governing.

Constants in Engine Governing (Die massgebenden Konstanten bei der Regelung der Kraftmaschinen und ihre Wechselbeziehungen). Herr Kröner. Mathematical discussion of the governing of reciprocating engines. Ills. 4800 w. Die Turbine—Aug. 20, 1910. No. 17450 D.

Engine Pistons.

Inequality of Piston Displacement. Guy Wise. Analysis of the problem of unequal piston displacement due to the angularity of the connecting rod. 600 w. Power—Sept. 27, 1910. No. 17510.

Engines.

The Locomobile or Superheated-Steam Unit. Warren H. Miller. An illustrated study of advanced Continental power practice. 3500 w. Engineering Magazine—Oct., 1910. No. 17552 B.

Combination Engine and Boiler. Warren H. Miller. Illustrated description of a German design combining engine, boiler and auxiliaries, having a water consumption of about 10 lbs. per h.p. hour. 1500 w. Power—Sept. 27, 1910. No. 17508.

Locomobiles, Boilers, Pumps, and Compressors at the Brussels Exposition (Lokomobilen, Dampferzeuger, Pumpen und Kompressoren auf der Weltausstellung in Brüssel 1910). Hermann Franke. A preliminary report. 5400 w. Zeitschr d Ver Deutscher Ing—Aug. 6, 1910. No. 17489 D.

Steam Engines and Turbines at the Brussels Exposition (Der Kraftmaschinenbau auf der Weltausstellung in Brüssel 1910). H. Dubbel. A detailed description of the exhibits. Ills. Serial. 1st part. 2700 w. Zeitschr d Ver Deutscher Ing—Aug. 6, 1910. No. 17490 D.

Engine Tests.

Tests of a Compound Superheated-Steam Engine with Live-Steam Intermediate Heating (Versuche an einer mit Zwischenüberhitzung durch Frischdampf arbeitenden Heissdampf - Verbundmaschine). M. F. Gutermuth and Prof. Watzinger. Describes the engine and tests and gives detailed results. Ills. 4200 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 1910. No. 17494 D.

See also Turbine Tests, under STEAM ENGINEERING.

Entropy.

The Physical Meaning of Entropy. A. L. Menzin. Gives definition and applies it to phenomena. 2000 w. Eng News—Sept. 1, 1910. No. 16848.

Exhaust Steam.

See Turbines, under STEAM ENGINEERING.

Mechanical Stokers.

The Underfeed Stoker. Illustrated description of two types made and used in England. 1500 w. Col Guard—Sept. 9, 1910. No. 17302 A.

Rotary Engines.

Recent Developments in Rotary Engines. An illustrated general review of recent types. 6000 w. Eng News—Sept. 15, 1910. No. 17106.

Smoke Prevention.

Smoke Prevention and the Efficiency of Firemen. A Concrete Instance. J. A. Switzer. Illustrates the improvement that followed the application of expert advice. 800 w. Engineering Magazine—Oct., 1910. No. 17554 B.

Stacks.

Some Notes on Power Station Chimneys. E. Kilburn Scott. Gives some general rules for chimney construction, and illustrates and describes types. 3500 w. Ir & Coal Trds Rev—Sept. 2, 1910. No. 17103 A.

Steam Piping.

Operation of the Steam Loop. F. L. Johnson. Illustrated explanation of the principles upon which the action of the steam loop depends. 1500 w. Power—Sept. 13, 1910. No. 17055.

Steam Properties.

Revision of the Steam Laws. Robert H. Smith. Discusses the difficulties of accurate measurement of temperature, and the strong probability of errors in the Steam Tables. 2700 w. Engr, Lond—Aug. 26, 1910. No. 16970 A.

Thermodynamic Units.

Two proposed Units of Power. Discussion of Prof. William T. Magruder's paper. 1800 w. Jour Am Soc of Mech Engrs—Sept., 1910. No. 16819 F.

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Turbines.

Steam Turbines for Both High and Low Pressure. Illustrates and describes details of the DeLaval mixed flow type. 2500 w. Ir Age—Sept. 15, 1910. No. 17131.

The Addition of Low-Pressure Turbines to Existing Steam Engines. Brief discussion of the problem from the commercial standpoint. 800 w. Elec Rev, Lond—Sept. 16, 1910. No. 17427 A.

Progress in the Use of Exhaust Steam Power. J. Burns. Abstract of a paper read before the Inst. of Min. Engrs. Considers types of exhaust steam turbines, and their successful applications, especially in collieries and iron and steel works. 7500 w. Ir & Coal Trds Rev—Sept. 16, 1910. No. 17442 A.

Steam Turbines (Turbines à Vapeur). A review of recent turbine literature and patents. Ills. Serial. 1st part. 5000 w. Rev de Mécan—Aug., 1910. No. 17220 E + F.

See also Engines, under STEAM ENGINEERING.

Turbine Tests

Test of a 15,000-KW. Steam-Engine-Turbine Unit. H. G. Stott and R. J. S. Pigott. Explains reasons for adopting this type to furnish additional power for the N. Y. subway, giving a description of the plant and a summary of the results obtained, with tabulated data acquired during tests and general discussion. Ills. 11400 w. Pro Am Inst of Elec Engrs—Sept., 1910. No. 17341 F.

Valve Gears.

Development Releasing Valve Gear. C. A. Tupper. An illustrated review of the development of this type of valve gear from the time of Watt, explaining the operation of each type. 2000 w. Power—Sept. 6, 1910. Serial. 1st part. No. 16933.

Valve Setting.

Setting Valves of a Williams Engine. Hubert E. Collins. Directions for the proper setting of the valves and the governor adjustment, with illustrations. 1500 w. Power—Sept. 20, 1910. No. 17316.

TRANSPORTING AND CONVEYING.

Cableways.

A Timber Transporting Plant in the Transylvanian Alps (Eine Holztransportanlage in den transsylvanischen Alpen). A. Pietrkowski. Describes an important cableway installation. Ills. 2000 w. Schweiz Bau—Aug. 6, 1910. No. 17295 B.

Coal Handling.

Feeding Devices for Coal-Transporting Plants in Boiler Houses (Speiseapparate bei Kohlentransportanlagen in Kesselhäusern). William Jaeger. The first part discusses the general requirements of these devices. Ills. Serial. 1st part. 1000 w. Elektrotech Rundschau—Aug. 25, 1910. No. 17475 D.

Conveyers.

A New Steel Belt Conveyer in Use in Sweden. Alfred Gradenwitz. Illustrated description of a flexible steel ribbon conveyer, reporting low costs. 2000 w. Eng & Min Jour—Sept. 3, 1910. No. 16899.

Dock Machinery.

See Docks, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Exhibitions.

Hoisting and Conveying Devices at the Brussels Exposition (Die Hebezeuge und Forderanlagen auf der Weltausstellung in Brussel 1910). Herr Aumund. Describes the exhibits of cranes, conveyers, dredges, hoisting engines, mine locomotives, elevators, etc. Ills. Serial. 1st part. 3000 w. Zeitschr d Ver Deutscher Ing—Aug. 13, 1910. No. 17493 D.

Lifting Magnets.

Lifting Magnets and Their Use in Foundries and Iron Works (Hebemagnete und ihre Anwendung in Giessereiund Hüttenbetrieben). Herr Wintermeyer. Describes a number of American and European devices and installations. Ills. Serial. 1st part. Giesserei-Zeit—Aug. 1, 1910. No. 17272 D.

Ore Handling.

A New Grab Bucket for Ore and Coal Handling Plants and Contractors' Use. Illustrated description of a bucket invented by H. P. Andresen. 1200 w. Eng News—Sept. 22, 1910. No. 17354.

The Handling and Storage of Iron Ores (Ueber Bewegung und Lagerung von Eisenerzen auf Grubenanlagen). K. Glinz. An illustrated description of methods of handling ore cars and storing ore at iron mines. Serial. 1st part. 4200 w. Stahl u Eisen—Aug. 31, 1910. No. 17268 D.

MISCELLANY.

Aeronautics.

The Work of the Government Aeronautical Committee. A review of work done, and of subjects of aeronautical interest, based on the first annual report of the Advisory Committee for Aeronautics. Ills. 2000 w. Engr, Lond—Sept. 9, 1910. No. 17309 A.

The Aeroplane Industry in France. W. F. Bradley. Brief illustrated review of the development. 1200 w. Mach, N Y—Sept., 1910. No. 16810 C.

Aeroplane Traffic. Marius C. Krarup. A reasoned comparison between aeroplanes, motor boats, bicycles, motor bicycles and automobiles, with regard to the chances for the immediate growth of an aeroplane industry. 2200 w. Automobile—Sept. 15, 1910. Serial. 1st part. No. 17122.

Airships and the Navy. Dr. Robert Grimshaw. Observations on the part that dirigible air craft will play in future conflicts on the ocean. 2800 w. Automobile—Sept. 29, 1910. No. 17572.

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The Aeroplane in War. Brief discussion of its possibilities and impossibilities. 1800 w. Sci Am Sup—Sept. 17, 1910. No. 17114.

The Electrical Equipment of an Airship. Frank B. Rae, Jr. A description of the plant for the "America," to furnish a lighting system, telephone system, and wireless outfit. 1000 w. Elec Wld—Sept. 22, 1910. No. 17361.

Proposed Transatlantic Airship Flight. Illustrated detailed description of the Wellman airship, in which a crew of six will attempt to cross the Atlantic. 3000 w. Sci Am—Oct. 1, 1910. No. 17537.

The Essential Problems of Aviation (Les Problèmes essentiels de l'Aviation). Hector Pouleur. An exhaustive summary of the problems of aeroplane design. Ills. Serial. 1st part. 1500 w. All Indus—Aug., 1910. No. 17230 D.

Progress in Aviation. Editorial review of progress during the past year, as shown at the recent international aviation meeting in Great Britain. 2000 w. Engng—Sept. 9, 1910. No. 17305 A.

Limits of Size in Aeroplanes. Editorial discussion of the limits of size and of load. 2500 w. Engng—Sept. 16, 1910. No. 17438 A.

The New Wright Biplane. Illustrates and describes the latest modification in which the front horizontal rudders are removed. 800 w. Sci Am—Sept. 3, 1910. No. 16869.

The Value of Anchored Tests of Aerial Propellers. Walter A. Scoble, and S. C. Carter. Read before the British Assn. An illustrated study. 2000 w. Engng—Sept. 9, 1910. No. 17307 A.

Aerial Propellers and Some Test Results. Charles Edward Larard and Robert Oliphant Boswall. A study of the design, construction, and testing of propellers. Ills. 3000 w. Engng—Sept. 2, 1910. No. 17091 A.

The Chalais-Mendon Aeronautic Laboratory and the Experiments on Aerial Propellers (Le Laboratoire aéronautique de Chalais-Mendon et les Experiences sur les Hélices propulsives). Lt.-Col. G. Espitallier. Describes the equipment and tests, and outlines the results. Ills. 2500 w. Génie Civil—Aug. 27, 1910. No. 17240 D.

Measuring Aeroplane Altitudes. Augustus Post. Explains methods used to determine the altitude reached by Walter R. Brookins, at Atlantic City. 1200 w. Am Mach—Vol. 33. No. 35. No. 16838.

The Movement of Fluids on Surfaces (Remarques sur l'Ecoulement des Fluides le Long des Surfaces). R. Tison. A theory, tested by Rateau's results, applicable to the design of aeroplanes and propellers. Ills. 4500 w. Rev de Mécan—Aug., 1910. No. 17219 E + F.

Agricultural Machinery.

Machinery at the General Agricultural Congress, Paris, June 14-21, 1910 (Les Machines au Concours général agricole de Paris). H. Pillaud. Illustrated description of the exhibits. Serial. 1st part. 3500 w. Tech Mod—Aug., 1910. No. 17224 D.

Exhibitions.

Engineering Exhibition at Olympia. Illustrated description of exhibits in the various departments of engineering. Plate. 4500 w. Engr, Lond—Sept. 9, 1910. Serial. 1st part. No. 17312 A.

The Naval, Mercantile Marine, and General Engineering and Machinery Exhibition, Olympia. Joseph Horner. Begins a description of exhibits of interest. Plate and Ills. 6500 w. Engng—Sept. 9, 1910. Serial. 1st part. No. 17303 A.

Guns.

Balloon Guns and Projectiles. An illustrated description of what is being done in Germany in the manufacture of ordnance for attacking balloons and airships. 1200 w. Engr, Lond—Sept. 16, 1910. No. 17439 A.

Modern Large-Caliber Ordnance (Sui moderni Cannoni di grande Calibro). G. Pecori-Giraldi. A consideration of their construction, difficulties, utility, etc. 6000 w. Riv Marit—July-Aug., 1910. No. 16554 E + F.

Safety Appliances.

The Mechanics of Saving Life. David S. Beyer. An illustrated general description of some of the principal features of safety work as at present developed in the U. S. Steel Corporation. 3500 w. Sci Am Sup—Sept. 10, 1910. Serial. 1st part. No. 17022.

Protective Appliances in Cotton Mills. H. M. Crawford. A fully illustrated article describing methods for reducing accident risks. 3500 w. Cassier's Mag—Oct., 1910. No. 17696 B.

Shoe Machinery.

Machinery in Shoe Making. S. B. Redfield. An illustrated general description of the Goodyear welt process of making shoes, and the ingenious devices used. 3500 w. Am Mach—Vol. 33. No. 31. No. 16162.

Sugar Machinery.

Sugar Cane-Crushing Plant at the Brussels Exhibition. Illustrated description of the exhibit of Messrs. Gebr. Stork & Co., of Hengelo, Holland. 1200 w. Engng—Aug. 12, 1910. No. 16691 A.

Textile Machinery.

Modern Cotton-Mill Efficiency. H. M. Crawford. Illustrates and describes safety appliances in carding, drawing and roving machinery. 3000 w. Cassier's Mag—Sept., 1910. No. 17165 B.

See also Safety Appliances, under MISCELLANY.

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MINING AND METALLURGY.

COAL AND COKE.

Accidents.

Coal Mining Fatalities in Belgium. Frederick L. Hoffman. Great care in timbering, ventilating, and hoisting results in low death rate. Explosives are prohibited in all fiery mines. 2200 w. Eng & Min Jour—Sept. 10, 1910. No. 17042.

Analysis.

The Determination of Sulphur in Coke (Zur Bestimmung des Schwefels im Koks). M. Holliger. A description of the barium chromate method, giving results of tests. 2000 w. Stahl u Eisen—Aug. 10, 1910. No. 17259 D.

Austria.

The Steiermark Coal Deposits (Mitteilungen über die steiermärkischen Kohlenvorkommen am Ostfuss der Alpen). B. Granigg. An exhaustive description of this Austrian coalfield. Ills. Serial. 1st part. 3500 w. Oest Zeit f Berg u Hüttenwesen—Aug. 13, 1910. No. 17278 D.

Coal Cutting.

Recent Developments in the Undercutting of Coal by Machinery. Edward W. Parker. Considers the use of mining-machines in bituminous mines, illustrating and describing types. 9500 w. Bul Am Inst of Min Engrs—Sept., 1910. No. 17347 F.

Coal-Cutting by Machinery in India. W. J. Greener. From the *Trans. Min. & Geol. Inst. of India.* Brief paper and discussion. Considers the advantages claimed, and the best motive power. 1600 w. Ir & Coal Trd Rev—Sept. 2, 1910. No. 17102 A.

Coke Oven Gas.

See Electric Power, under COAL AND COKE.

Coke Ovens.

The Elliott-Jones Vertical Coke-Oven. T. Campbell-Futers. Illustrated description. 1500 w. Ir & Coal Trds Rev—Sept. 16, 1910. No. 17443 A.

Recent Developments in Coke-Oven Construction and Progress in the Introduction of Mechanical Operation (Ueber die neuere Entwicklung der Kokerei nach Bauart der Oefen und Ausbildung des Mechanischen Betriebes). Fr. Herbst. Read at the Düsseldorf Congress. An exhaustive record of progress in coking practice. Ills. Serial. 1st part. Stahl u Eisen—Aug. 31, 1910. No. 17267 D.

Coking.

Tarless Coke. Describes a plant for the production of coke from which all the tar-like matter has been removed. The process is the distillation of the coal under a high vacuum. 1500 w. Engr, Lond—Aug. 26, 1910. No. 16975 A.

Electric Power.

Electrical Equipment of the Rose Bridge and Douglas Bank Collieries, Wigan. W. Winsborough. Brief illustrated description, especially the method of preventing leakage, and the protection against shock. 800 w. Elect'n, Lond—Aug. 26, 1910. No. 16950 A.

Electric Power Plants in the Saarbrücken District (Die Kraftwerke der Kgl. Bergwerksdirektion zu Saarbrücken). Herrn Mengelberg and Peucker. Detailed descriptions of plants using coke-oven gas both in gas engines and under boilers. Ills. 21000 w. Glückauf—Aug. 27, 1910. No. 17285 D.

Explosions.

The Prevention of Coaldust Explosions by Zone Systems. E. O. Simcock. Abstract of paper read before the N. Staffordshire Inst of Min. & Mech. Engrs. A discussion of whether there is yet sufficient data available to determine the practical utility of these systems. 4000 w. Col Guard—Sept. 2, 1910. No. 17090 A.

Great Britain.

Geological Research in the Coalfields. Information from the geological survey report for 1909. 3000 w. Col Guard—Aug. 26, 1910. Serial. 1st part. No. 16959 A.

India.

Indian Mining in 1909. Facts from the report of J. R. R. Wilson, H. M. chief inspector of mines in British India, so far as they relate to coal mining. 4000 w. Col Guard—Sept. 9, 1910. Serial. 1st part. No. 17301 A.

Iowa.

Coal Fields of Iowa and Missouri. Henry Hinds. Information concerning the extent of the beds, quantity of coal, prospecting and mining methods. 3500 w. Mines and Min—Sept., 1910. No. 16878 C.

Mexico.

Exploration of Certain Iron-Ore and Coal Deposits in the State of Oaxaca, Mexico. J. L. W. Birkinbine. Describes exploratory work, especially the location of coal-deposits. Also describes the country and customs, geology and general mining and industrial conditions. Ills. 5500 w. Bul Am Inst of Min Engrs—Sept., 1910. No. 17345 F.

Mine Gas.

Barometric Pressure and Liberation of Firedamp. Leon Morin. Abstract translation from *Ann. des Mines.* Experiments indicate that the outflow of gas in a mine is influenced by the variations in atmospheric pressure. 4500 w. Eng & Min Jour—Sept. 17, 1910. No. 17150.

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Mining.

Working a Steep Coal Seam. Austin Y. Hoy. Illustrated description of methods used in the mines of the Pacific Coast Coal Co., at Coal Creek, Wash. 2500 w. Mines & Min—Sept., 1910. No. 16877 C.

Missouri.

See Iowa, under COAL AND COKE.

Peat.

Canada's Experimental Peat Plants. A. R. Maujer. Illustrates and describes the method of handling peat on the government bog-lands and its use in a suction gas producer plant. 2200 w. Power—Sept. 13, 1910. No. 17054.

Generation of Power from Peat. T. Arthur Mighill. Abstract of a paper read before the Am. Peat Soc. Discusses the proportion of moisture, preparation of fuel, facilities required for the continuous development of 1000 h.p., and drying the peat. 3200 w. Power—Sept. 6, 1910. No. 16936.

Production.

The World's Coal Production and Consumption. Information from the Board of Trade returns. 3500 w. Col Guard—Sept. 2, 1910. No. 17089 A.

Sampling.

Coal and Coke Sampling. E. G. Bailey. Directions for properly sampling at mines and from cars. 6000 w. Mines & Min—Sept., 1910. No. 16880 C.

Stripping.

Stripping Coal Beds. Illustrates and describes methods in use in the anthracite region of Pennsylvania, and in bituminous coal in Illinois. 1800 w. Mines & Min—Sept., 1910. No. 16876 C.

Tennessee.

The Wind Rock Coal Mine. W. S. Hutchinson. Gives illustrated description of the geology, mining system, undermining, etc. 3000 w. Mines & Min—Sept., 1910. No. 16875 C.

Virginia.

Correllation Thacker Field. Audley H. Stow. Illustrates and describes deposits near the Tug River, in Virginia. 1500 w. Mines & Min—Sept., 1910. No. 16879 C.

Wyoming.

Southern Rock Springs Coal Field, Wyoming. A. R. Schultz. Information concerning the development, available coal, markets, etc. 1500 w. Min Wld—Sept. 3, 1910. No. 16929.

COPPER.

Arizona.

The Superior and Boston Mine. R. L. Herrick. Illustrated description of the system of mining and pump arrangement at McGaw shaft, Globe, Arizona. Copper sulphides. 4500 w. Mines & Min—Sept., 1910. No. 16883 C.

Assaying.

Rapid Electrolytic Determination of Copper. R. C. Benner. Information concerning methods and results, describing apparatus utilizing the rotating electrode. 1500 w. Eng & Min Jour—Sept. 10, 1910. No. 17041.

Copper.

Concentration at Cananea, Mexico. Courtenay De Kalb. Describes this plant as it was in April, 1910, following the ore through the mill. Ills. 4000 w. Min & Sci Pr—Sept. 10, 1910. No. 17124.

Dust Settling.

See Smelting, under COPPER.

Matte Converting.

Recent Practice in Copper Matte Converting. Redick R. Moore. Describes improved appliances and methods. 6500 w. Eng & Min Jour—Sept. 3, 1910. No. 16900.

Mexico.

Las Pilares Mine. Edward M. Robb, Jr. Describes deposits of copper ore in Mexico, the mining methods, delayed filling system of stoping, transportation, etc. Ills. 6500 w. Mines & Min—Sept., 1910. No. 16882 C.

Smelter Fumes.

Smelter Fume in Shasta County, California. Sumner S. Smith. An illustrated account of present conditions. 1400 w. Min & Sci Pr—Sept. 17, 1910. No. 17386.

See also Smelting, under COPPER.

Smelting.

Hydrocarbon Gas vs. Coke in Smelting Furnaces. John S. Loder. Describes a system of producing gas and smelting therewith, devised by the author, and claiming to be economical and efficient. Ills. 1000 w. Min Wld—Sept. 3, 1910. No. 16927.

Smelting at Nishni Tagil in the Ural Mountains. F. W. Draper. Describes a combination of crude methods and modern practice. 3500 w. Eng & Min Jour—Sept. 24, 1910. No. 17409.

Pyrite Smelting and Sulphuric Acid Manufacture. F. J. Falding and J. Parke Channing. Considers several furnaces desirable to produce gas of uniform composition and quantity for acid manufacture. 4000 w. Eng & Min Jour—Sept. 17, 1910. No. 17146.

Smelting Fine Dust at Copper Queen Smeltery. George B. Lee. Reports experiments which proved that dust chambers 125 ft. long were efficient when gas velocity did not exceed 150 ft. per minute. Diagrams. 700 w. Eng & Min Jour—Sept. 10, 1910. No. 17038.

GOLD AND SILVER.

Alaska.

Some Economic Gold Deposits of Alaska. Francis Church Lincoln. Brief descriptions of the more important gold deposits, with information concerning them. 5000 w. Eng & Min Jour—Sept. 17, 1910. No. 17145.

Assaying.

Experiments with Portland Cement Cupels. T. P. Holt and N. C. Christen-

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sen. Describes the experiments and results. 2000 w. Eng & Min Jour—Sept. 17, 1910. No. 17148.

Australia.

Metallurgical Practice in Western Australia. A. E. Drucker. An account of the practice of the leading gold-producers and the production. Ills. 1200 w. Min & Sci Pr—Sept. 24, 1910. No. 17564.

British Columbia.

The Nickel Plate Mine and Mill. Illustration and brief account of this successful gold mine. 1800 w. Min & Sci Pr—Aug. 27, 1910. No. 16854.

California.

Nevada City Gold Mining District, California. A. H. Martin. Historical review of the development of this gold district. Ills. 2000 w. Min Wld—Sept. 24, 1910. No. 17413.

Chlorination.

Electrolytic Chlorine at Mount Morgan, Queensland. B. Du Faur. Read before the Aust. Inst. of Min. Engrs. Detailed description of the method of producing chlorine. Ills. 3500 w. Queens Gov Min Jour—Aug. 15, 1910. No. 17448 B.

West Works—Mount Morgan Chlorination. C. H. Humphreys. Read before the Aust. Inst. of Min. Engrs. A résumé of the work, as an example of what can be effected in recovering the values from oxidized low grade ores. 4000 w. Queens Gov Min Jour—Aug. 15, 1910. No. 17449 B.

Dry Chlorination of Complex Sulphide Ores. H. L. Woolf. Abstract from *Jour. of W. Chem. & Met.* Detailed description of the Malm process. 1200 w. Aust Min Stand—Aug. 3, 1910. No. 16976 B.

Cobalt.

Cobalt in 1910. Arthur A. Cole. Reviews the geology, engineering features and future outlook of this mining district. Ills. 2500 w. Engineering Magazine—Oct., 1910. No. 17547 B.

Colorado.

Geology of Part of Ten-Mile Range, Colorado. Arthur Lakes. Describes the faulting, the prevailing rocks, veins, etc. Ills. 2000 w. Min Wld—Sept. 10, 1910. No. 17060.

Prospecting in San Juan Mountains, Colorado. Arthur Lakes. Illustrates and describes the characteristics of this region. 2000 w. Min Wld—Sept. 17, 1910. No. 17174.

Cyaniding.

The Effect on the Solubility of Gold When Ore Is Crushed Between Iron Surfaces. J. M. Tippett. Reports experiments which seem to show that gold crushed between iron surfaces is not as susceptible to the action of cyanide. 1800 w. Met & Chem Engng—Sept., 1910. No. 16871 C.

Modern Cyanding Practice and Apparatus (Die Praxis des modernen Cyanidprozesses und die zugehörigen Maschinenanlagen). W. Heym. A brief illustrated review of modern developments. Serial. 1st part. 1500 w. Elektrochem Zeitschr—Aug., 1910. No. 17252 D.

Dredging.

See French Guiana, under GOLD AND SILVER.

Fiji.

Geological Features of Fiji. N. D. Cochrane. Information concerning the alluvial, reef, and dredging possibilities. 5000 w. Aust Min Stand—Aug. 3, 1910. No. 16977 B.

French Guiana.

Conditions for Gold Dredging in French Guiana. Albert Bordeaux. Describes the climatic and labor conditions, stating the requirements, costs, etc. 2000 w. Eng & Min Jour—Sept. 17, 1910. No. 17149.

Hydraulic Mining.

Hydraulic Mining of Auriferous Gravels. James W. Phillips. A description of hydraulic mining in California. Ills. Also discussion. 15800 w. Jour W Soc of Engrs—Aug., 1910. No. 17329 D.

See also Débris Barrier, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Mexico.

Geology of Hostotipaquillo Ore Deposits. S. J. Lewis. Notes on the geology of this district in Mexico, having extensive deposits of low grade, silver-gold milling ores, and possibly copper. Ills. 2500 w. Min & Sci Pr—Sept. 10, 1910. No. 17126.

San Rafael and Anexas Mining Co. of Pachuca. E. Girault. Abstract of a paper read before the Mex. Min. & Met. Inst. Describes the properties of this company and their development. 4000 w. Min Wld—Sept. 24, 1910. No. 17412.

Montana.

Judith Basin, Montana. Illustrates and describes this region, its mines and their development. 1500 w. Min & Sci Pr—Sept. 24, 1910. No. 17563.

The Radersburg Mining District of Montana and Some Interesting Features of Its Geology. D. C. Bard. Map, with history and present development, and description of the geology, and mineralization. Veins of auriferous pyrite in a gangue of calcite and quartz. 1200 w. Jour Assn of Engng Socs—July, 1910. No. 16828 C.

Mew Mexico.

New Mexico Gold Gravels. J. A. Carruth. Describes deposits of gold-bearing material of great depth and extent. Ills. 3000 w. Mines & Min—Sept., 1910. No. 16884 C.

Precipitation.

Precipitating Gold and Silver from Cyanide Solutions. G. Witteveen. Read before the Inst. of Mines & Met., Mex.

We supply copies of these articles. See page 327.

Notes on the De Wilde process. 2500 w. Aust Min Stand—Aug. 24, 1910. No. 17446 B.

Rand.

Rand Mine Returns and the Fathomage System. W. W. Mein. Abstract from advance proofs of an article presented to the Inst. of Min. & Met. A critical review of an address by H. F. Marriott, on methods and costs. 5500 w. Min & Sci Pr—Sept. 24, 1910. No. 17565.

Deep Mining in Transvaal. Roland Gascoyne. Discusses the difficulties due to increase in temperature and pressure. Ills. 2500 w. Min & Sci Pr—Sept. 10, 1910. No. 17125.

IRON AND STEEL.

Analysis.

Iron and Steel Analysis. Warren I. Keeler. Describes a modification of the oxidation method for sulphur. 1400 w. Ir Age—Sept. 1, 1910. No. 16832 C.

Armor Plate.

New Designs of High-Resistance Armor Plate for Dreadnoughts (Neue widerstandsfahigere Panzer für Dreadnoughts mit günstigerer Form für den Einbau). Viktor Tilschkert. Describes recent improvements in armor plate practice. Ills. Serial. 1st part. 2000 w. Oest Zeitschr f Berg- u Hüttenwesen—Aug. 6, 1910. No. 17277 D.

Bessemer Process.

The Present Position of the Basic Bessemer Process in Germany (Zum heutigen Stand des basischen Windfrischverfahrens in Deutschland). Herr Esser. Read at the Düsseldorf Congress. Reviews recent progress, with illustrations from modern plants. Ills. 5400 w. Stahl u Eisen—Aug. 3, 1910. No. 17253 D.

Blast Furnace Charging.

Blast Furnace Charging Abroad. Dr. Alfred Gradenwitz. Illustrates and describes the use of wire rope cableways in Euorpean plants. 1800 w. Ir Age—Sept. 1, 1910. No. 16836 C.

Blast Furnace Charging with Telpher Lines. Plan and illustrated description of a blast-furnace charging plant with telpher lines. 1500 w. Ir & Coal Tds Rev—Sept. 16, 1910. No. 17444 A.

Blast Furnace Gas.

Recent Practice in Gas Cleaning in Germany (Ueber den heutigen Stand der Gichtgasreinigung in Deutschland). Curt Grosse. Read at the Düsseldorf Congress. A detailed review of methods and apparatus. Ills. Serial. 1st part. 3000 w. Stahl u Eisen—Aug. 17, 1910. No. 17260 D.

Blast Furnace Slag.

Aluminium Silicate, Calcium Silicate, and Calcium Aluminate (Die Tonerdesilikate, Kalksilikate und Kalkaluminate). B. Neumann. A study of the properties of these three important constituents of blast furnace slags. Ills. 6000 w. Stahl u Eisen—Aug. 31, 1910. No. 17269 D.

The Colloseus Process for Making Slag Cement. F. A. Talbot. Describes the process, the essential feature being the granulation of the molten furnace slag with epsom salts. 1500 w. Eng & Min Jour—Sept. 24, 1910. No. 17408.

China.

Hanyang Iron and Steel Works. George Chamier. A brief description of the works at Hankow. 2500 w. Engng—Sept. 9, 1910. No. 17306 A.

Electrometallurgy.

The Present Status of Electric Steel Processes. Prof. B. Neumann. Read before the Düsseldorf Cong. Illustrated review of some of the latest improvements in electric steel practice, showing the extension of the field of the electric furnace. 2500 w. Ir & Coal Trds Rev—Aug. 26, 1910. No. 16991 A.

The Nathusius Electric Steel Furnace (Der Elektrostahlofen System Nathusius). B. Neumann. A description of this new combined arc and resistance furnace. Ills. 3500 w. Stahl u Eisen—Aug. 17, 1910. No. 17261 D.

See also Foundry Furnaces, under MACHINE WORKS AND FOUNDRIES.

Germany.

The Future of the German Steel Industry. Discusses the present condition of affairs, the steel syndicate, competition, and related subjects. 4000 w. Ir & Coal Trds Rev—Aug. 26, 1910. No. 16990 A.

Ingot Iron.

American Ingot Iron—Its Development and Production. George L. Fowler. Describes the development of the process and present practice of manufacture, explaining its properties and its demonstration of the probable truth of the electrolytic theory of corrosion. Ills. 3300 w. Ry Age Gaz—Sept. 30, 1910. No. 17574.

Ingots.

The Closing and Welding of Blow Holes in Steel Ingots. Henry M. Howe. Abstract of a paper presented at the Sheffield meeting of the British Assn. Investigates a method of avoiding a portion of the expense of cropping. 2000 w. Ir Trd Rev—Sept. 29, 1910. No. 17573.

Lake Superior.

Production and Resources of Lake Iron Region. John Birkinbine. Information concerning Lake Superior iron ore, which represents about 80% of total production of the United States. 2000 w. Min Wld—Sept. 3, 1910. No. 16928.

Mexico.

The Iron and Steel Industry of Mexico. John Birkinbine. An illustrated descriptive review of present conditions. 9000 w. Ir Age—Sept. 8, 1910. No. 16972.

See also same title, under COAL AND COKE.

New Jersey.

Deep Mining and Treatment of New Jersey Iron Ore. Illustrates and describes

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modern methods and equipment of an old mining property. 2000 w. Ir Trd Rev—Sept. 22, 1910. No. 17380.

Norway.

The South Varanger Iron Ore Deposits and Separating and Briquetting Plants. Map and illustrated description of large deposits in northern Norway and their development. 3500 w. Engng—Sept. 16, 1910. No. 17436 A.

Ore Resources.

The Iron Ore Resources of the World. L. de Launay. Read before the Int. Cong. of Geologists. Discusses some of the factors determining availability and the sources of supply and probable changes that will influence the production. 2500 w. Ir Age—Sept. 22, 1910. No. 17357.

Plates.

The Etching of Thin Plates (Das Beizen von Feinblechen). W. Krämer. Describes various methods and types of apparatus for cleaning plates for galvanizing. Ills. 3200 w. Stahl u Eisen—Aug. 24, 1910. No. 17264 D.

Rolling Mills.

Power Required for Rolling Steel. J. A. Knesche. First of two articles giving an illustrated description with data and results of tests. 3500 w. Engineering Magazine—Oct., 1910. No. 17550 B.

The Manufacture of Rolled H-Beams. G. E. Moore. Read before the Ir. & St. Inst., England. Reviews the development of the universal mill for rolling of structural shapes. Ills. 5500 w. Ir Age—Sept. 29, 1910. No. 17559.

The Flattening Effect of Rolling (Das Breiten beim Walzen). Correspondence on E. M. Scheld's paper on this subject in *Stahl und Eisen* for March 9, 1910. Ills. 3000 w. Stahl u Eisen—Aug. 17, 1910. No. 17263 D.

Electric Driving of Plate Rolling Mills (Commande électrique de Laminoirs à Toles). A. Mauduit. Describes the installation and practice at the Louvroil plate works. Ills. 5000 w. Génie Civil—Aug. 27, 1910. No. 17239 D.

Segregation.

Segregation in Soft Steel Ingots. From a paper by Prof. Wüst and Herr Felser detailing the results of valuable research work on the effect of segregation on rolled material as shown in tensile and shock tests. Ills. 2500 w. Ir Age—Sept. 29, 1910. No. 17561.

Steel Works.

Design of Steel Mill Building. F. E. Davidson. Brief description of the new open hearth building of the Ill. Steel Co., at its South Works, with general discussion. 3000 w. Jour W Soc of Engrs—Aug., 1910. No. 17330 D.

Control of Extension and Improvement Expenditure in Steel Works (Zur Kontrolle der Neubaukosten auf Hüttenwerken). Discusses provision for improvements, supervision of improvement work, and the determination of costs. Ills. 3000 w. Stahl u Eisen—Aug. 3, 1910. No. 17254 D.

LEAD AND ZINC.

British Columbia.

Geology and Ore Deposits of La France Creek. Newton W. Emmens. Illustrated account of the West Kootenay division of British Columbia, describing the district, particularly along La France Creek, and the La France mines. 1700 w. Min Wld—Sept. 10, 1910. No. 17058.

Lead Smelting.

Trail Smelter and Lead Refinery. J. M. Turnbull. Illustrated description of the equipment, methods of smelting and electrolytic refining. 7000 w. Mines & Min—Sept., 1910. No. 16885 C.

MINOR MINERALS.

Asbestos.

The Asbestos Industry in Central Wyoming. F. H. Barrow. Information concerning the quantity, quality, and development. Ills. 800 w. Eng & Min Jour—Sept. 17, 1910. No. 17147.

Cement.

The Portland Cement Industry of the United States and Canada. Arthur Charles Davis. Reviews the development of the industry. 4500 w. Inst of Civ Engrs—No. 3851. No. 17377 N.

The Rotary Kiln. Ellis Soper. On the development and uses. Ills. 2200 w. Jour Am Soc of Mech Engrs—Oct., 1910. No. 17582 F.

The Fuel Requirements of the Rotary Cement Kiln. W. S. Landis. Discusses this subject from both the theoretical and practical standpoints. 2500 w. Met & Chem Engng—Sept., 1910. No. 16872 C.

The Cement Mill of the Los Angeles Aqueduct. Illustrated detailed description of a 1000-bbl. cement mill operated municipally. 2000 w. Eng Rec—Sept. 17, 1910. No. 17158.

The Equipment of the Cement Mill of the Portland Cement Company of Utah. Leroy A. Palmer. Illustrated description of a remodeled mill equipment, as an example of the most advanced type of cement manufacture. 2200 w. Eng News—Sept. 8, 1910. No. 16998.

Fireclay.

The Application of the Grog in Firebrick Manufacture. Gilbert Rigg. Considers the important parts played by the grog in fireclay ware, the chemical composition, the application of the grog in such a manner as to give the greatest density, etc. 2200 w. Met & Chem Engng—Sept., 1910. No. 16873 C.

Magnesite.

The Economic Value of the Kraubath Magnesite (Ueber die Beurteilung des wirtschaftlichen Wertes des Gel-Magnesits von Kraubath). A. Granigg. A detailed study of extensive magnesite depos-

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its in Austria. Ills. Serial. 1st part. 1500 w. Oest Zeitschr f Berg u Hüttenwesen—Aug. 27, 1910. No. 17279 D.

Tin.

Tin Mining in Bolivia. William Gray and Arnold L. Halden. Information concerning the centers of production, economic conditions, and mining laws. Map. 1600 w. Min Mag—Sept., 1910. No. 17517 B.

Mount Bischoff. F. H. Bathurst. An illustrated descriptive account of the greatest tin mine in the world, its discovery and history. 3500 w. Min Mag—Sept., 1910. No. 17516 B.

Tungsten.

Scheelite. Brief illustrated account of a new tungsten mining camp in Nova Scotia. 1200 w. Can Min Jour—Sept. 15, 1910. No. 17172.

MINING.

Accidents.

Accidents from Explosions in 1909. Information from the last report of H. M. Inspectors of explosives. 2500 w. Col Guard—Aug. 26, 1910. No. 16960 A.

The Prevention of Mine Accidents. Report of a Committee of the Am. Min. Cong. giving draft of a law for the regulation of quarrying and metalliferous mining, urging its uniform adoption in the hope of reducing accidents. 9000 w. Eng & Min Jour—Sept. 24, 1910. No. 17407.

Depth.

Practical Limit to the Depth of Mines. Dr. Niess, in *Umschau*. Discusses the improvements that have made possible deep mining, and the greatest depth at which mining can be carried on. 2000 w. Sci Am Sup—Sept. 24, 1910. No. 17364.

Drills.

Compressed-Air Drills (La Perforation mécanique par Percussion à l'Air comprimé). Henri Petit Bois. General notes on the calculation of output, air consumption, etc. Ills. 2500 w. All Indus—Aug., 1910. No. 17231 D.

Rock Drills in Sweden (Die Verwendung von Gesteinbohrmaschinen in den schwedischen Bergwerken). E. Mossberg. Describes the drills used, the applications made of them, and the results obtained. Ills. 6500 w. Glückauf—Aug. 6, 1910. No. 17280 D.

Electric Hoisting.

Bibliography to Accompany Paper on Electric Mine-Hoists. L. B. Rushmore and K. A. Pauly. 9 pages. Bul Am Inst of Min Engrs—Sept., 1910. No. 17346 F.

Electric Power.

Electricity in Mining (Electrizität im Bergbau). W. Philippi. A brief review of its various applications. Ills. 3000 w. Elek Kraft u Bahnen—Aug. 24, 1910. No. 17483 D.

Explosive Testing.

Some Modern Developments in Methods of Testing Explosives. Charles E. Munroe. Illustrates and describes the Pittsburg testing station and its equipment, and the experimental investigations carried out. 8000 w. Pro U S. Nav Inst —Sept., 1910. No. 17323 F.

Haulage.

Underground Haulage (Streckenförderung unter Tage). Fr. Tillmann. Read at the Düsseldorf Congress. A review of mechanical haulage practice in Germany. Ills. Serial. 1st part. 3600 w. Glückauf —Aug. 6, 1910. No. 17281 D.

See also Signalling, under STREET AND ELECTRIC RAILWAYS.

Hoisting.

Underground Winding Plant of the New Modderfontein G. M. Co. R. H. Copeland. Abstract of paper before the S. African Inst. of Elec. Engrs. Shows difficulties met in installing the cable, getting the hoist into position, and describes the system of control, etc. 2000 w. Elect'n, Lond—Aug. 26, 1910. No. 16953 A.

The Economy and Safety of Modern Hoisting Plants (Wirtschaftlichkeit und Sicherheit moderner Schachtförderanlagen). A. Winkel. A review of the status and recent development of hoisting machinery. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Aug. 6, 1910. No. 17492 D.

Hoisting Engines.

Twin Tandem Winding Engines. Illustrates and describes engines recently built for a colliery in South Wales. Plate. 1200 w. Engr, Lond—Sept. 9, 1910. No. 17313 A.

Results of Tests of Steam and Electric Hoisting Plants (Ergebnisse von Untersuchungen an elektrisch und mit Dampf betriebenen Fördermaschinen). Tabulated results of tests on plants in the Dortmund district. 1500 w. Glückauf—Aug. 27, 1910. No. 17287 D.

Law.

New Zealand and American Mining Law—A Contrast. A. C. Veach. Abstract from reports on "Mining Laws of Australia and New Zealand." Government-Printer, Washington, 1910. 1800 w. Min & Sci Pr—Aug. 27, 1910. No. 16855.

Methods.

Mining and Stoping Methods in the Coeur d'Alene. John Tyssowski. Long tunnel entries are common. Methods are illustrated and described. 3000 w. Eng & Min Jour—Sept. 3, 1910. No. 16898.

Lessons from Gilpin County Practice. George E. Collins. Abstract from lectures before the Colo. Sch. of Mines. Describes good and bad points of methods in a district of small mines and variable ore bodies. Ills. 5400 w. Min & Sci Pr—Sept. 17, 1910. No. 17384.

Underground Methods on the Gogebic Range. Percival S. Williams. Read before the L. Superior Min. Inst. Illustrates and describes development work. 2200 w. Min Wld—Sept. 10, 1910. No. 17059.

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Plants.

Low-Pressure Steam Turbines in Mining Plants. Frank C. Perkins. Illustrates and describes applications of these turbines which utilize the exhaust steam. 1500 w. Min Wld—Sept. 3, 1910. No. 16925.

Shaft Sinking.

Concrete Shaft Linings and the Deepening of the Shaft of the Austrian Mining and Smelting Company (Ueber Schachtbetonierungen im allgemeinen und das Abteufen der Schächte bei der Oesterreichischen Berg- und Hüttenwerks-Gesellschaft). A Czermak. Detailed description of the sinking and tubbing work. Ills. Serial. 1st part. 3000 w. Oest Zeitschr f Berg u Hüttenwesen—Aug. 6, 1910. No. 17276 D.

Skip Hooks.

Kibble Hooks. From *Zeit. für Berg., Hutten und Salinenwesen.* Substances of reports required by the Prussian Minister of Commerce, on the different types of kibble hooks in use. Ills. 1200 w. Col Guard—Aug. 26, 1910. No. 16961 A.

Stowing.

Effect of Sand Filling on the Surface in the Königin Luise District (Wirkungen des Abbaues mit Sandspülversatz auf das Deckgebirge im Felde der Königin Luise-Grube). Herr Ackermann. Describes earth subsidence in this German coal field. Ills. 4000 w. Glückauf—Aug. 20, 1910. No. 17283 D.

Stripping.

See same title, under COAL AND COKE.

Surveying.

Details of Mine Surveying. A. E. Robinson. Describes methods recently employed in conducting an extensive survey. 6000 w. Min & Sci Pr—Sept. 3, 1910. No. 17011.

Timbering.

Underground Steel Construction in Mines. R. B. Woodworth. An illustrated review of uses made of steel in mines, showing types and discussing stresses in mine timbering. 4500 w. Min Wld—Sept. 17, 1910. No. 17173.

ORE DRESSING AND CONCENTRATION.

Briquetting.

Nodulizing Wet Iron Ores. Abstract of a paper by Friedrich Witte, in *Stahl und Eisen*, describing the nodulizing process at the Fernie Works, near Giessen, as applied to a soft brown iron ore. Ills. 1000 w. Ir Age—Sept. 1, 1910. No. 16835 C.

Copper.

The Ohio Concentrator. Leroy A. Palmer. Describes this concentrator of the Ohio Copper Co., in Utah, and its operation. Ills. 3000 w. Min & Sci Pr—Sept. 3, 1910. No. 17012.

Crushing.

Comparison of Gyratory and Jaw Crushers. H. L. Wollenberg. Shows that each type has a field in which it is superior, and discusses the limits of each. 2500 w. Eng & Min Jour—Sept. 10, 1910. No. 17039.

Lead Milling.

The New Ore-Dressing Plant at the Diepenlinchen Mine near Stolberg (Die neue Erzaufbereitungsanlage der Grube Diepenlinchen bei Stolberg). Herr Cabolet. Illustrated description of an important German plant for the treatment of lead-zinc ores. Ills. 5000 w. Glückauf—Aug. 27, 1910. No. 17284 D.

Roasting.

Notes on Roasting and Sintering; With Particular Reference to the Dwight & Lloyd Process. F. M. Smith. Reports concerning the development and results of this process. 2500 w. Jour Assn. of Engng Socs—July, 1910. No. 16830 C.

Stamp Mills.

Pittsburg—Silver Peak Mining Co.'s Mills, Nevada. A. H. Martin. Detailed description of the most economical mill in southern Nevada. 2000 w. Min Wld—Sept. 10, 1910. No. 17061.

Tailings Disposal.

Silting at Waihi. Arthur Jarman. An illustrated account of an inquiry into the damage claimed, and suggestions for improving conditions. 1800 w. Min Mag—Sept., 1910. No. 17515 B.

MISCELLANY.

Canada.

The Eastern Canadian Mineral Belt. Theo. F. Von Wagenen. Describes the region between the Great Lakes and Hudson Bay. 2500 w. Min & Sci Pr—Sept. 17, 1910. No. 17385.

China.

Mines in the Yangtzi Valley, China. Kimio Nishizawa. An account of mining in China, and the steps taken to develop the industry with information concerning conditions, climate, etc. 7500 w. Jour Soc of Arts—Sept. 16, 1910. No. 17416 A.

Conservation.

President Taft on Conservation of Mineral Land. Remarks taken from the speech at St. Paul, before the Nat. Conservation. Cong. recommending leasing mineral rights only in government coal, oil and phosphate lands. 2500 w. Eng & Min Jour—Sept. 10, 1910. No. 17037.

India.

The Mineral Production of India. Information from the last issue of the Records of the Geological Survey of India, concerning development, production, trade, etc. 2000 w. Col Guard—Aug. 26, 1910. No. 16962 A.

Ore deposits.

The Effect of Oxidation on the Value of a Mineral Deposit. J. Bowie Wilson. Discusses effects that should be understood in valuing a new mine or prospect. Its effect on the contents of the ore, on the physical character of the ore body,

etc. 3500 w. Anst Min Stand—Aug. 24, 1910. No. 17447 B.

Exploration of Contact Metamorphic Ore Deposits. C. A. Stewart. A summary of modern theories and opinions of the character and genesis of such deposits. 2500 w. Eng & Min Jour—Sept. 10, 1910. No. 17040.

Manganese-Ore in Unusual Form. William P. Blake. Describes a deposit near Tucson, Ariz., as an example of ore-deposition by vadose upward capillary flow of metal-bearing solutions with concentration at the surface of the country rock. 800 w. Bul Am Inst of Min Engrs—Sept., 1910. No. 17348 F.

Quebec.

Report of Mining Operations in the Province of Quebec During the Year 1909. Theodore C. Denis. Abstract of the report of the Supt. of Mines. 4000 w. Can Min Jour—Sept. 1, 1909. No. 16893.

Refractory Materials.

Changes in the Composition of Firebricks. Dr. Blasberg. Read before the Düsseldorf Cong. Tabulated analyses of several kinds of fireproof brick from blast furnaces, cupolas, etc., and of coke oven bricks, and silica bricks from open hearth furnaces, with a study of the changes. 2500 w. Ir & Coal Trds Rev—Aug. 26, 1910. No. 16989 A.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Accidents.

The Campaign Against Accidents on the Chicago & North Western. Explains the methods being adopted to reduce accidents. 3000 w. Ry Age Gaz—Sept. 2, 1910. No. 16860.

Signalling.

Note on the Double Application of the M. D. M. Automatic Route Combiner to the Hydraulic Operating Gear and to the Interlocking of the Points and Signals at the Landy Signal Cabins, near Paris, by the French Northern Railway. A. Moutier. Ills. 3300 w. Bul Int Ry Cong—July, 1910. No. 17543 G.

Railway-Signalling in India. Charles William Hodson. Describes the development of signalling apparatus, discussing improvements desired, methods, etc. Discussion. Ills. 28000 w. Inst of Civ Engrs, No. 3802—Dec. 14, 1909. No. 17367 N.

Report No. 4 for Great Britain and Colonies, Belgium, France, and Italy on the Question of Operation of Switches and Signals. L. Weissenbruch and J. Verdeyen. A discussion of improved control installations for the operation of points and signals, comparing systems, etc. Ills. 14500 w. Bul Inst Ry Cong—July, 1910. No. 17544 G.

The New Electro-Pneumatic Signal System for the West Side of the Central Station at Amsterdam (De nieuwe electro-pneumatische Seininrichting voor de Beveiliging van de Westzijde van het Centraalstation te Amsterdam). A. van Driel van Wageningen. Illustrated detailed description. 7000 w. De Ingenieur—Aug. 20, 1910. No. 17505 D.

Train Dispatching.

Telephone Train Dispatching. K. W. Endres. An illustrated explanation of its advantages, and detailed discription. 1800 w. Elec Rev, N. Y—Sept. 24, 1910. Serial. 1st part. No. 17406.

Train Speed.

Determination of Regular and Minimum Running Time (Die Bestimmung der regelmässigen und der kürzesten Fahrzeit). Herr Wagner. Describes the method of determining running time and establishing schedules, taking account of curvature and grades. Ills. 2200 w. Glasers Ann—Aug. 15, 1910. No. 17456 D.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Braking Power Chart. Gives a chart showing weight of car and braking power, with explanation. 700 w. Ry & Loc Engng—Sept., 1910. No. 16897 C.

Rapidity of Braking with Pressure and Vacuum Brakes (Fortpflanzungsgeschwindigkeit der Bremswirkung bei Druckluft- und Vakuumbremsen). A. Langrod. Examines the factors influencing the speed of brake action. Ills. 3000 w. Glasers Ann—Aug. 1, 1910. No. 17453 D.

Electrification.

The Electrification of Steam Railways. An editorial study of papers on this subject recently read before the joint meeting of the British and American Mechanical Engineering Societies. 5000 w. Eng News—Sept. 22, 1910. No. 17355.

The Electrification of Steam Roads. R. R. Keely. Summarizes the advantages and disadvantages of electrification, discussing the relative merits of the various systems, and gives tabulated lists of important electric railways. Ills. 3500 w. Can Engr—Sept. 15, 1910. Special. No. 17182 C.

Electric Power for Railroad Operation. F. Darlington. Based on a lecture delivered before the Richmond R. R. Club. Discusses the commercial aspect of electrification, the systems, comparison with steam, and between old and new electric systems. 4000 w. Elec Jour—Sept., 1910. No. 16825.

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Freight Cars.

The Economics of Large-Capacity Freight Cars (L'Intérêt économique des Wagons de grande Capacité). Pierre Arbel. Discusses the use of large-capacity cars in Europe from the points of view of the railways and the shippers, and examines the principles of proper rate making. Ills. 14000 w. Mem Soc Ing Civ de France—July, 1910. No. 17203 G.

Locomotive Construction.

Equalization of Mallet Articulated Locomotives. W. E. Johnston. A criticism of the three point support used in American practice in designing this type of engine. Ills. 800 w. Am Engr & R R Jour—Sept., 1910. No. 16921 C.

Progress of Locomotive Construction in Canada. Lacey R. Johnson. Illustrates and describes various designs for the varied services required. 2500 w. Can Engr—Sept. 15, 1910. Special. No. 17180 C.

Locomotive Design.

The Design of Rolling Stock for Smooth-Rail Working on Heavy Gradients. Frederick William Bach. Discusses the constructional and economic considerations which should govern the design. Also discussion. Ills. 22000 w. Inst of Civ Engrs, No. 3787—Jan. 11, 1910. No. 17366 N.

Locomotive Efficiency.

Influence of Steam Pressure on Locomotive Efficiency. Charles R. King. Considers the gradual increase in steam pressures, and discusses the influence upon the economy in compound locomotives, giving tabulated data relating to the reduction of steam pressures on the State Railways of Italy. 3000 w. Mach (Ry Ed)—Sept., 1910. No. 16986 C.

Locomotives.

Development of Articulated Locomotives. C. H. Caruthers. Illustrated review of types since 1831. 2500 w. Ry Age Gaz—Sept. 30, 1910. No. 17576.

Report on the Question of Locomotives and Rolling Stock of Narrow-Gauge Light Railways. Moriz Jesser. Illustrated discussion of the latest types. 31000 w. Bul Int Ry Cong—July, 1910. No. 17541 G.

Locomotives at the Brussels Exhibition. Illustrated detailed description of exhibits. 1500 w. Engr, Lond—Aug. 26, 1910. Serial. 1st part. No. 16973 A.

Locomotives for the Carolina, Clinchfield & Ohio Railway. Illustrated description of a Mallet 2-6-6-2, and a Pacific 4-6-2. 1500 w. Ry & Loc Engng—Sept., 1910. No. 16896 C.

Freight (2-6-6-2 Type) and Passenger (4-6-2 Type) Locomotives for a Low Grade Line. Illustrated descriptions of engines for the Carolina, Clinchfield & Ohio Railway. 1600 w. Am Engr & R R Jour—Sept., 1910. No. 16922 C.

Articulated Compound Locomotives, 0-8-8-0 Type. Illustrated description of engines designed by the Am. Loc. Co. for the Norfolk & Western Railway. 900 w. Am Engr & R R Jour—Sept., 1910. No. 16920 C.

Heavy Pacific Tpye Locomotive for the Vandalia. Illustrated detailed description of an engine for heavy passenger service, with record of typical runs. 1000 w. Ry Age Gaz—Sept. 23, 1919. No. 17398.

Four-Cylinder Compound Locomotive with Superheater "Helicoidalen Cascade." Illustrated detailed description of one of a series of 70 locomotives built for fast service on long divisions on the Eastern Ry. of France. 4000 w. Ry & Engng Rev—Sept. 17, 1910. No. 17175.

New French Pacific Express Engine, Chemin de Fer du Midi. Illustration and brief description of this new engine for passenger service. Plate. 150 w. Engr, Lond—Sept. 16, 1910. No. 17441 A.

Four-Cylinder Compound with Three Coupled Axles on the Austrian State Railways (Note sur la Locomotive compound à Quatre Cylinders à trois Essieux accouplés, Essieux porteur à l'avant et Bogie à l'Arrière, Serie 210, des Chemins de Fer I. R. de l'Etat Autrichien). Jacques Neblinger. Detailed description of a locomotive of the 2-6-4 type. Ills. 4500 w. Rev Gen d Chemins de Fer—Aug., 1910. No. 17218 G.

Water-Tube Locomotives for the Northern Railway of France (Locomotive avec Foyer à Tubes d'Eau de la Compagnie du Chemin de Fer du Nord). Brief description, with plate. Ills. 2500 w. Génie Civil—Aug. 13, 1910. No. 17234 D.

Locomotive Superheaters.

Churchward Superheater. Trans. from *Rev. Gen. des Chem. de Fer.* Illustrated description. 1500 w. Ry & Engng Rev—Sept. 17, 1910. No. 17176.

Churchward Superheaters on the Locomotives of the Great Western Railway (Note sur le Surchauffeur Système Churchward des Locomotives du Great Western Railway). L. Fort and F. Houlet. Describes the Churchward superheater and compares with other types. Ills. 2000 w. Rev Gen d Chemins de Fer—Aug., 1910. No. 17217 G.

Locomotive Throttles.

New Throttle Valves for Superheated-Steam Locomotives (Neue Ventilregler für Heissdampf-locomotiven). M. Henze. Describes briefly the Schmidt & Wagner Throttle. Ills. 1000 w. Elektrotech Rundschau—Aug. 4, 1910. No. 17473 D.

Motor Cars.

Auto as Locomotive. William D. Ennis. Considers the motor car from the standpoint of the automobile designer discussing the proportions of a typical example. Ills. 3000 w. Automobile—Sept. 29, 1910. No. 17570.

We supply copies of these articles. See page 327.

Converted Automobile Motor Car. Illustrated description of a car remodeled and used on the A., T. & S. F. Ry. in Texas. 600 w. Ry Age Gaz—Sept. 9, 1910. No. 17017.

A Freight and Passenger Railway Using Gasoline Motor Cars. Information concerning a standard-gauge railway in Iowa, over which both freight and passenger traffic will be handled by means of cars driven by gasoline engines. 1800 w. Eng Rec—Sept. 10, 1910. No. 17049.

Shops.

Locomotive Repair Shop Practice. Ethan Viall. Illustrates and describes work at the C., R. I., & P. R. R. shops, Silvis, Illinois. 1800 w. Mach (Ry Ed)—Sept., 1910. No. 16985 C.

The Modern Locomotive Repair Shop. A. D. Porter. Gives plans and description of such shops able to care for 10 to 12 locomotives. 1500 w. Can Engr—Sept. 15, 1910. Special. No. 17181 C.

New Shops at the Midland Railway Carriage and Wagon Works, Derby. Illustrated detailed description of new features introduced and general description of the works. 4000 w. Engr, Lond—Sept. 2, 1910. No. 17098 A.

The Borsig Locomotive Shops. V. Litz. Illustrates and describes interesting features of shop construction, and special machines. 1500 w. Am Mach—Vol. 33. No. 37. No. 17116.

Equipment of the Schneidemühl Locomotive Repair Shops (Maschinelle Einrichtungen der Lokomotiv-Reparatur-Werkstatt Schneidemühl). Herr Wolff. Detailed description of this German plant. Ills. Serial. 1st part. 2300 w. Glasers Ann—Aug. 15, 1910. No. 17455 D.

Sleeping Cars.

A New Idea in Sleeping Cars. M. M. Hunting. Illustrates and describes the novel features of an improved car for interurban service. 500 w. Sci Am—Oct. 1, 1910. No. 17536.

Train Lighting.

The Production of Oil Gas in Producers and Its Transmission under High Pressure (Oelgasherstellung in Generatoren und Gasfernversorgung in Hochdruckleitungen). Fritz Landsberg. Gives results and costs of operation of the Pankow plant. Ills. 3300 w. Glasers Ann—Aug. 1, 1910. No. 17454 D.

Train Resistance.

Freight Train Resistance. Discussion of Prof. Edward C. Schmidt's paper. 4000 w. Jour Am Soc of Mech Engrs—Sept., 1910. No. 16818 F.

PERMANENT WAY AND BUILDINGS.

Bridges.

Report No. 11 for Russia on the Question of Strengthening the Bridges with a View to Increasing the Weight of Locomotives and the Speed of Trains. N. Belelubsky and N. Bogouslawsky. The suitable strengthening of existing metal bridges is considered. Ills. 31600 w. Bul Int Ry Cong—July, 1910. No. 17542 G.

Coaling Stations.

Operating and Maintenance Costs of Locomotive Coal and Ash Handling Stations. Henry J. Edsall. Gives data in regard to the cost of operating and maintaining various types of locomotive coaling stations. 1500 w. Eng News—Sept. 8, 1910. No. 17004.

See also same title, under CIVIL ENGINEERING, CONSTRUCTION.

Construction.

Grading Work on the C. N. O. Railway, Toronto-Ottawa Line. Illustrates and describes methods of excavating and filling, and some of the bridges. 500 w. Can Engr—Sept. 15, 1910. Special. No. 17177 C.

Curves.

Straight Run-Outs of Cant at the Ends of Circular Curves on Railways. Fulwar Craven Fowle. A study of the effect of cant, with calculation of the required cant. 2500 w. Inst of Civ Engrs—No. 3867. No. 17276 N.

Rail Joints.

Improvements and Experiments in Rail Joints. Information from recent papers before the International Railway Congress. 2500 w. Eng News—Sept. 15, 1910. No. 17107.

Reconstruction.

Recent Improvements of the Oregon & Washington Railroad. A brief account of extensive improvements in progress and proposed at Tacoma and Seattle, Wash. Ills. 1200 w. Eng Rec—Sept. 24, 1910. No. 17401.

Stations.

Reinforced Concrete Depot at Grand Prairie, Tex. Brief illustrated description of a reinforced-concrete station, costing $6000 for a town of 300 inhabitants. 200 w. Ry Age Gaz—Sept. 9, 1910. No. 17014.

Terminals.

Opening of the Pennsylvania Terminal Station in New York. Brief illustrated account of the work of bringing this railroad into the metropolis. 1500 w. Sci Am—Sept. 10, 1910. No. 17020.

Inaugural of the New York Extension of the Pennsylvania Railroad: Opening of the Passenger Station. An illustrated summary of the main structural features of this great work and a historical sketch of the development of the project. Also editorial. 11000 w. Eng News—Sept. 15, 1910. No. 17104.

Progress at the Grand Central Terminal. Illustrations showing present conditions at this New York City terminal, and showing the progress on the new station. Descriptive notes. 1000 w. Ry Age Gaz—Sept. 16, 1910. No. 17134.

We supply copies of these articles. See page 327.

Track Construction.

The Strengthening of Railway Track for High-Speed Traffic. Notes from papers on this subject at the recent International Railway Congress, with editorial. 4000 w. Eng News—Sept. 8, 1910. No. 17006.

Track Location.

Angular Loading-Track Arrangement for Panama R. R. Docks at Cristobal. E. B. Karnopp. A study of track layout for serving the new dock, showing that the position of loading tracks can affect the cost of handling about 20%. Plans. 700 w. Eng News—Sept. 29, 1910. No. 17527.

Tunnels.

Supplement to Report No. 1 on the Question of Long Railway Tunnels, Construction, Ventilation and Operation. Francis Fox. Great town tunnels in Great Britain. 100 w. Bul Int Ry Cong—July, 1910. No. 17545 G.

A New Alpine Tunnel Project—the Little St. Bernard (Une nouvelle Percée des Alpes—le Petit Saint-Bernard). J. Révil. A description of the project based on an examination of the region. 4000 w. Rev Gen Sci—Aug. 30, 1910. No. 17222 D.

Water Towers.

The New Water Works at the Potsdam Station, Berlin (Das neue Wasserwerk am Potsdamer Bahnhof in Berlin). Herr Zinkeisen. Describes a locomotive water station and pumping plant. Ills. 3000 w. Glasers Ann—Aug. 1, 1910. No. 17452 D.

TRAFFIC.

Demurrage.

The Car Demurrage Bureaus. William Bender Wilson. Remarks on the advantages derived from these bureaus, and the agitation with the object of their abandonment, giving a summary of the reasons advanced. 1500 w. Ry Age Gaz—Sept. 9, 1910. No. 17016.

MISCELLANY.

Canada.

Railway Development in Canada. R. A. Baldwin. Reviews the beginning and growth of the system of railways, and some points relating to the early history of railway building in Great Britain. 3500 w. Can Engr—Sept. 15, 1910. Special. No. 17178 C.

Railway Situation in Canada. J. L. Payne. Interesting statistics relating to the railway facilities, and information concerning their financial condition. Map. 3000 w. Can Engr—Sept. 15, 1910. Special. No. 17179 C.

Great Britain.

Prof. Dalby's Address to Section G of the British Association. (Abstract.) Gives reliable statistics relating to British railways, discussing electrification. Considers electric service necessary where frequent starts and stops are involved, and shows the influence of scientific discovery on the railways. 5000 w. Elect'n, Lond—Sept. 2, 1910. No. 17078 A.

Italy.

Transportation and Traffic in Italy. Logan G. M'Pherson. Preliminary report to the Nat. Waterways Com. Information concerning waterways and railways, reviewing their history and development. 4000 w. Ry Age Gaz—Sept. 9, 1910. No. 17013.

Java.

Railways and Tramways in Java (De Spoor- en Tramwegen op het Eiland Java). J. Th. Gerlings. A brief review of the transportation facilities. 4000 w. De Ingenieur—Aug. 6, 1910. No. 17503 D.

Philippines.

Philippine Railway Company Lines. Abstract from the *Far Eastern Rev.* Illustrates and describes construction work under very difficult conditions. 1600 w. Ry Age Gaz—Sept. 30, 1910. No. 17575.

Sicily.

Narrow-Gauge Railways in Sicily (La Rete complementare Sicula a Scartamento ridotto). A detailed study of secondary lines in Sicily. Ills. Serial. 1st part. 3000 w. Ing Ferro—Aug. 1, 1910. No. 17246 D.

Switzerland.

Transportation and Traffic in Switzerland. Logan G. M'Pherson. A preliminary report to the Nat. Waterways Com. A review of the history of the Swiss railways. 3000 w. Ry Age Gaz—Sept. 30, 1910. No. 17577.

STREET AND ELECTRIC RAILWAYS.

Bradford, Eng.

The Tramways of Bradford. Illustrated general description of the tramway undertaking and its operation. Map. 6000 w. Tram & Ry Wld—Sept. 1, 1910. No. 17082 B.

Car Barns.

Park Terminal Car House, Baltimore. Illustrated detailed description, as an example of the best modern practice. 2000 w. Elec Ry Jour—Sept. 17, 1910. No. 17132.

Cars.

New Open Cars of the Massachusetts Electric Companies. An account of rapid methods of construction. Ills. 1500 w. Elec Ry Jour—Oct. 1, 1910. No. 17578.

Conductor Maintenance.

Brooklyn Line Department—Third Rail Maintenance, High-Tension Work, Feed-

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ers and Miscellaneous Features. Fifth article of a series describing the line department of the Brooklyn Rapid Transit System. Ills. 3000 w. Elec Ry Jour—Sept. 10, 1910. No. 17010.

Germany.

The Electric Railways in Germany. Wilhelm Weehmann. An outline of the electric railways in Germany at the present time. 3000 w. Ry Age Gaz—Sept. 23, 1910. No. 17399.

Interurban.

Promotion of Interurban and Branch Railways. J. Stanley Richmond. A criticism of the government regulations in Canada. 3000 w. Can Engr—Sept. 15, 1910. Special. No. 17183 C.

Interurban Railways Centering in Toronto. Illustrated account of the lines entering Toronto, and information relating to them. 2500 w. Can Engr—Sept. 15, 1910. Special. No. 17184 C.

Southern Cambria 1200-Volt D. C. Railway. Illustrated description of an interurban line in western Pennsylvania. 1200 w. Elec Ry Jour—Sept. 3, 1910. No. 16864.

The Heddernheim - Oberursel - Hohe Mark Railway (Vorortbahn Heddernheim-Oberursel-Hohe Mark). Brief description of an interurban high-speed line near Frankfurt a. M. Ills. 2200 w. Elek Kraft u Bahnen—Aug. 4, 1910. No. 17479 D.

Java.

See same title, under RAILWAY ENGINEERING, MISCELLANY.

Locomotives.

An Electric-Turbine Locomotive. Illustrated description of the recently constructed Reid-Ramsey electro-turbo locomotive. 1200 w. Tram & Ry Wld—Aug. 4, 1910. No. 16487 B.

Electric Turbine Locomotive Built at Glasgow. Illustrated description of a novel engine—the Reid-Ramsay locomotive. 600 w. Ry & Loc Engng—Oct., 1910. No. 17655 C.

New 60-Ton Locomotives of Illinois Traction Company. Illustrated detailed description of locomotives to be used in handling freight. 1000 w. Elec Ry Jour—Oct. 8, 1910. No. 17737.

An Electric Freight Locomotive for City Lines. Brief description of a locomotive built for the Brooklyn lines of the Rapid Transit Co. 1000 w. Eng News—Sept. 29, 1910. No. 17532.

The Pennsylvania Electric Locomotives and Their Field of Operation. H. L. Kirker. A conversational detailed description, with illustrations. 3000 w. Elec Jour—Sept., 1910. No. 16822.

Monorail.

Gyroscope in Monorail Cars (Chemins de Fer Monorails à Gyroscopes stabilisateurs). Ch. Dantin. A brief review of gyroscopic theories and of monorail systems. Ills. 2000 w. Génie Civil—Aug. 20, 1910. No. 17237 D.

The Technical and Economic Possibilities of Gyroscope Monorailways (Die technischen und wirtschaftlichen Aussichten der einschienigen Kreiselbahnen). Alfred Kürth. Replies to criticisms and discusses the advantages of the monorail system, particularly Scherl's. Ills. 5000 w. Elek Kraft u Bahnen—Aug. 14, 1910. No. 17480 D.

Motor Pinions.

Breakages of Railway Motor Pinions. George L. Fowler. Reports an investigation made of pinion breakage and the conclusions. Ills. 2500 w. Elec Ry Jour—Sept. 3, 1910. No. 16865.

Operation.

Some Practical Hints Regarding Electric Tramway Operation. Directions for troubles that frequently occur. 2200 w. Elec Rev, Lond—Aug. 26, 1910. No. 16944 A.

Pittsburg.

Rapid Transit Problems. Report on conditions at Pittsburg from investigations made by Bion J. Arnold. Ills. 3000 w. Munic Jour & Engr—Sept. 7, 1910. No. 16982.

Rack Railways.

The Mendel and Rittner Railway (Die Mendel- und Rittnerbahn). M. Jesser. Describes an electric railway in Austria, partly on the adhesion, and partly on the rack, system. 3500 w. Mitt d Ver f d Förd d Lokal u Strassenbahnwesens—Aug., 1910. No. 17251 F.

Rail Corrugation.

Some Notes on Rail Corrugation. J. H. M. Andrews. Outlines some of the more prominent causes and gives the opinion of the writer based on observation and experiment. 1500 w. Elec Ry Jour—Sept. 3, 1910. No. 16867.

Rail Corrugation. A Busse. Abstract of a report on replies received to questions sent out. Points to the conclusion that the trouble is due to the rail metal or to peculiarities caused by the method of rolling. 3500 w. Elect'n, Lond—Sept. 16, 1910. No. 17429 A.

Rail Joints.

Theory of Rail Joints. Felix Lange. Abstract of a paper before the Am. St. & Int. Ry. Assn. Discusses causes of wear and the requirements welded joints must meet. 1200 w. Elec Ry Jour—Oct. 12, 1910. (Daily Ed.) No. 17806.

Railless.

The Mercedes-Stoll Railless Electric Traction System of the Vienna Street Railways (Viermotorige elektrische Oberleitungs-Automobilwagen System "Mercedes-Electrique-Stoll" der Wiener städtischen Strassenbahnen). Arthur Ertel. Brief description of the line and equipment. Ills. 1200 w. Elek Kraft u Bahnen—Aug. 14, 1910. No. 17481 D.

Rails.

History of Street Railway Rails. E. B. Entwistle. Abstract of a paper read be-

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fore the Cont. Elec. Ry. Assn. Illustrated review of types of rail used. 1200 w. Elec Ry Jour—Sept. 24, 1910. No. 17389.

Shops.

Repair Shops of the Bangor Railway & Electric Company. The extensive shops at Bangor, Maine, are illustrated and described. 2000 w. Elec Ry Jour—Sept. 24, 1910. No. 17388.

Signalling.

Automatic Section Blocking for Electric Haulage Ways or Similar Electric Railway Installations (Selbsttätige Streckenblockung für elektrisch betriebene Förderbahnen oder ähnliche Eisenbahnanlagen). L. Kohlfürst. Describes the Siemens-Schuckert system. Ills. 3000 w. Elek Kraft u Bahnen—Aug. 4, 1910. No. 17478 D.

Single Phase.

A Norwegian Single Phase Railway. Brief illustrated description of the Thamshavn Lokken electric railway. 700 w. Ry Age Gaz—Sept. 2, 1910. No. 16859.

Subways.

Tri-Borough Subway and Elevated System, New York City. Map and description of the proposed system having a total length of 44.21 miles. 1500 w. Eng Rec —Sept. 10, 1910. No. 17046.

Subway Stations.

Construction of the Rue de Crimée Station on the Paris Metropolitan (Note sur l'Exécution de la Station du Chemin de Fer Métropolitain de Paris, "Rue de Crimée"). M. Suquet. Describes the design of a subway station to meet special and difficult conditions. Ills. 2500 w. Ann d Ponts et Chaussées—1910-IV No. 17206 E + F.

Types of Subway Stations on the North-South Railway in Paris (Note sur divers Types du Stations souterraines établies dans les Voies étroites pour le Chemin de Fer Nord-Sud de Paris). M. Bechmann. Describes four types of stations on single-track lines. Ills. 6000 w. Ann d Ponts et Chaussées—1910-IV. No. 17205 E + F.

Supplies.

Ordering and Standardization of Supplies on the London County Council Tramways. Describes the catalogues prepared to overcome the uncertain methods of describing supplies. 1000 w. Elec Ry Jour—Sept. 3, 1910. No. 16866.

Track Maintenance.

The Economical Maintenance of Tracks and Roadways. Martin Schreiber. Abstract of paper read before the Am. St. & Int. Ry. Assn. Discusses some of the more important features of the work, stating conclusions. Ills. 3000 w. Elec Ry Jour—Oct. 12, 1910. (Daily Ed.) No. 17807.

Track Deflection.

A Study of Track Deflection and Materials. Information from the annual report of the Board of Supervising Engineers of Chicago Traction. 1500 w. Elec Ry Jour—Oct. 8, 1910. No. 17738.

Traffic.

Traffic Promotion in New England. Illustrated report of methods found successful. 8500 w. Elec Ry Jour—Oct. 8, 1910. (Convention No.) No. 17739.

Traffic Promotion in Central New York and Atlantic Coast States. Illustrated report of methods, equipment, etc. 13500 w. Elec Ry Jour—Oct. 8, 1910. (Convention No.) No. 17740.

Traffic Methods of Electric Railways in Ohio, Indiana and Michigan. Describes successful promotion methods, illustrating stations, etc. 24000 w. Elec Ry Jour—Oct. 8, 1910. (Convention No.) No. 17741.

Traffic Work on Electric Railways in the Mississippi Valley. An illustrated article describing organization, advertising methods, equipment, stations, etc. 13000 w. Elec Ry Jour—Oct. 8, 1910. (Convention No.) No. 17742.

Traffic Features of Some of the Pacific Coast Roads. An illustrated account of the terminals, equipment, methods, etc. 7500 w. Elec Ry Jour—Oct. 8, 1910. (Convention No.) No. 17743.

Train Dispatching.

Telephone Dispatching and Train-Order Signals for Electric Railways. Editorial on the methods of handling and regulating traffic on electric interurban railways. 1500 w. Eng News—Sept. 29, 1910. No. 17531.

Trolley Lines.

See Insulators, under ELECTRICAL ENGINEERING, TRANSMISSION.

Valuation.

Methods of Conducting the Valuation of the Physical Properties of the Chicago Consolidated Traction Co., with Summaries of Cost. Philip J. Kealy. Describes methods and costs of track and power house valuation. 3500 w. Engng-Con—Sept. 28, 1910. No. 17522.

Methods of Conducting the Valuation of the Physical Properties of the Chicago Consolidated Traction Co., with Summaries of Costs. Philip J. Kealy. Gives data of the distribution system. 1500 w. Engng-Con—Oct. 5, 1910. No. 17705.

Valuation of the Track of the Detroit Street Railway System. Explains methods used in track valuation, including 21 types of rail sections. 1500 w. Eng News—Sept. 8, 1910. No. 17001.

The Valuation of the Detroit Street Railways. An explanation of the situation, with comparison of valuations made for the city, with those made for the company. 4000 w. Eng News—Aug. 25, 1910. No. 16634.

Wheels.

The Wear of Wheels. J. A. O'Brien. A discussion of flange wear in rail vehicles. 1400 w. Elec Rev, Lond—Aug. 26, 1910. No. 16942 A.

We supply copies of these articles. See page 327.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brickbuilder. *m.* Boston.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Castings. *m.* Cleveland, O.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Commercial Vehicle. *m.* New York.

Compressed Air. *m.* New York.
Comptes Rendus de l' Acad. des Sciences. *w.* Paris.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Giesserei-Zeitung. *s-m.* Berlin.
Glasers Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Horseless Age. *w.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. N. E. Water Works Assn. *qr.* Boston.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metallurgical and Chem. Engng. *m.* New York.
Métallurgie. *w.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railway Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Rudder. *m.* New York.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yale Scientific Monthly. *m.* New Haven.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.